Software

PHOTOMOD 4.4

Module

Aerial Triangulation

USER MANUAL

Racurs, Moscow, 2009

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1. PHOTOMOD AT – data collection for the Aerial Triangulation process

PHOTOMOD AT (Aerial Triangulation) is a module of data collection for digital aerial triangulation (phototriangulation) for the block of images. Processing images in **PHOTOMOD AT** includes interior orientation, entering control points coordinates and measuring control points on the images, adding tie points in the overlapping areas between strips and adjacent images. Once all necessary operations in **PHOTOMOD AT** are done the block is adjusted in **PHOTOMOD Solver** module (see the corresponding User Manual). As a result of block adjustment the exterior orientation parameters are computed and the single stereopairs may be transferred to **PHOTOMOD DTM** and **PHOTOMOD StereoDraw** modules for DTM extraction and 3D feature collection.

2. Installation and starting

PHOTOMOD AT is installed along with the **PHOTOMOD** system by starting **setup.exe** file from the installation CD. See also **readme.txt** file on your CD for the installation instructions. **PHOTOMOD AT** is started for selected project from **PHOTOMOD Montage Desktop** program (see the corresponding User Manual) by the icon .

3. Working with PHOTOMOD AT

Work in **PHOTOMOD AT** is organized as several steps procedure (Fig.1).

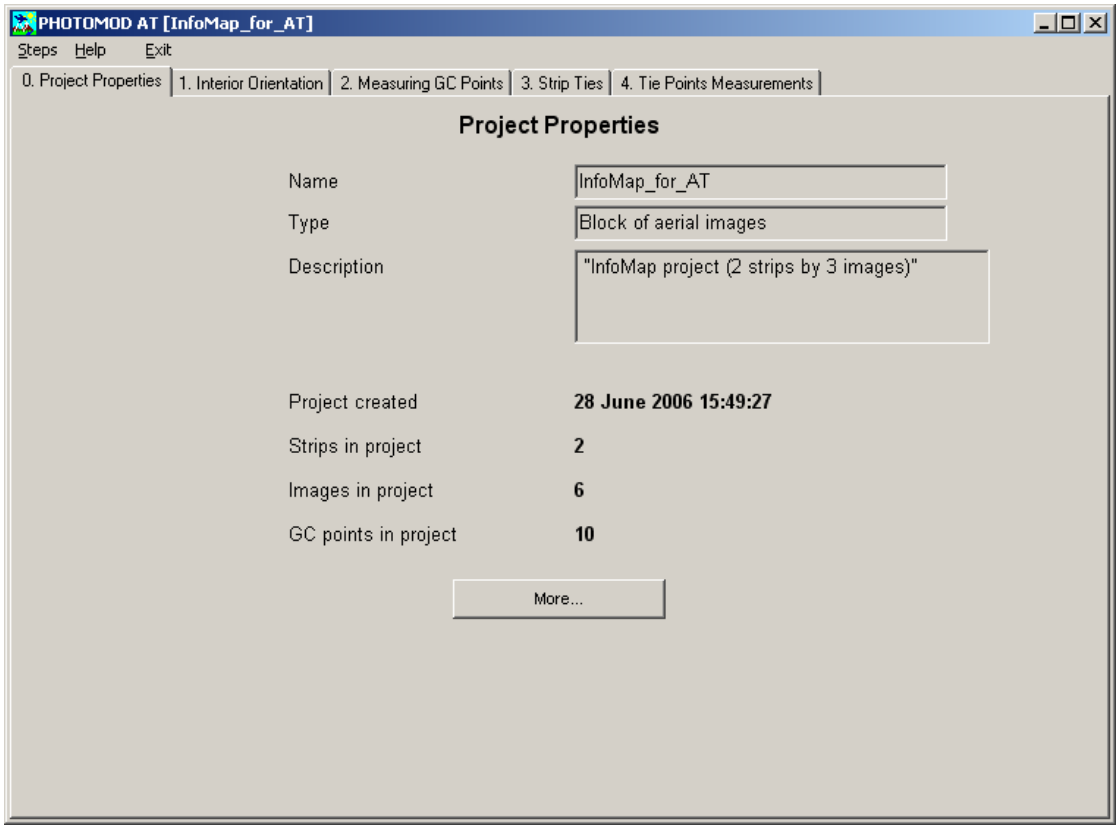


Fig.1 **Project Properties** tab

This window contains several tabs corresponding to each processing step. Select the corresponding item from the **Steps** menu or click the corresponding tab to move to the particular processing step. If working with a new project, it is recommended to execute all

steps one by one in their natural order. After completing some of necessary steps you can come back to any steps already completed and repeat some operations. Possible changes you may do in this case, will be saved and take effect to all subsequent steps.

Different project types are processed in **PHOTOMOD AT** module in different order. Aerial survey projects have to pass the following stages:

- **Project properties** (step 0) – displaying general project information.
- **Interior orientation** (step 1) – interior orientation of block images.
- **Measuring GC points** (step 2) – adding, identification and measurements of the GCPs on images of the block.
- **Strip ties** (step 3) – measurements of tie points between adjacent strips
- **Tie points measurements** (step 4) – measurements of tie points on overlapping images in the strip.

Workflow provided for scanner images projects differs and is described in the chapter 4.3 Processing of scanner monoblock in PHOTOMOD AT and 4.4 Processing of scanner stereoblock in PHOTOMOD AT.

3.1 *Project properties*

At the tab “0” – **Project properties** (Fig.1) the project name, type and description are displayed. Project type may be either **Central projection** or **Scanner survey** (see the chapter 4 Project types).

Besides, there are some information on the project creation, number of strips, images and ground control points in it.

The **More** button opens a window **Project properties**, containing more details about the project, see description of the window in **PHOTOMOD Montage Desktop** User Manual.

3.2 *Interior orientation*

The interior orientation procedure is used to find the position and the orientation of the film coordinate system relatively to the coordinate system of the digital image. Besides, during interior orientation the parameters describing a systematic film distortion can be found.
The parameters defined in the process of interior orientation are used to transform measured image point coordinates from the digital image coordinate system to the film coordinate system.

3.2.1 Coordinates transformation

Five types of transformation from the digital image coordinate system to the film coordinate system are implemented in the **PHOTOMOD AT** module. Which one is to be applied depends on the **Fiducial marks data** option selected when the camera data were entered (see the chapter “Catalog of cameras” of **PHOTOMOD Montage Desktop** User Manual).

If only principal point coordinates were measured during interior orientation (**Principal point** option in camera description), the transformation is described by the following equation:

$$x = x_c - x^o_c$$
$$y = y_c - y^o_c \ ,$$

where

x,y - the coordinates of a point in the film coordinate system;
x_c,y_c - the coordinates of a point in the digital image coordinate system;

x^o_c, y^o_c - the coordinates of the principal point in the digital image coordinate system;

In this case the axes of the film coordinate system are parallel to the axes of the digital image coordinate system.

If in the process of interior orientation the fiducial marks coordinates were measured, the transformation depends on the **Fiducial marks data** option selected when the camera data were entered.

In case of the **Calibrated distances** option the transformation is described by the following equation:

$$x = x^*_c + k_x(\cos\varphi\, x_c - \sin\varphi\, y_c)$$
$$y = y^*_c + k_y(\sin\varphi\, x_c + \cos\varphi\, y_c),$$

where

x^*_c , y^*_c - the coordinates of the origin of the film coordinate system in the digital image coordinate system;

φ - the rotation angle of the film coordinate system relatively of the digital image coordinate system;

k_x, k_y - the coefficients describing a film deformations along the x, y axes.

If no data about fiducial distances is available (**Fiducial marks** option) the transformation is described by the following equation:

$$x = x^*_c + \cos\varphi\, x_c - \sin\varphi\, y_c$$
$$y = y^*_c + \sin\varphi\, x_c + \cos\varphi\, y_c,$$

where x, y, x^*_c , y^*_c, φ parameters have the same values as in the previous equation.

If **Fiducial marks data** option is set to **Fiducial coordinates**, both affine and projective transformations may be applied to transform the point coordinates from the digital image coordinate system to the film coordinate system and correct the systematic errors.

The affine transformation is more suitable for aerial photo processing, while the projective transformation - for processing of terrestrial (close range) photos on the glass plates.

An affine transformation is described by the following equation:

$$x = a_o + a_1 x_c + a_2 y_c$$
$$y = b_o + b_1 x_c + b_2 y_c ,$$

where a_i, b_i - the parameters of the transformation.

A projective transformation is described by the following equation:

$$x = \frac{A_1 x_c + A_2 y_c + A_3}{C_1 x_c + C_2 y_c + 1}$$

$$y = \frac{B_1 x_c + B_2 y_c + B_3}{C_1 x_c + C_2 y_c + 1}$$

where A_i, B_i, C_i - the parameters of the transformation.

Please remember that you need to measure at least 3 fiducial marks to find affine transformation parameters and at least 4 fiducial marks – to find projective transformation parameters.
If less than 3 fiducial marks have been measured (others are not visible), the simple Helmert transformation is used.

3.2.2 **Interior orientation** tab

Select the **Interior orientation** tab of the **PHOTOMOD AT** window to execute the interior orientation procedure.

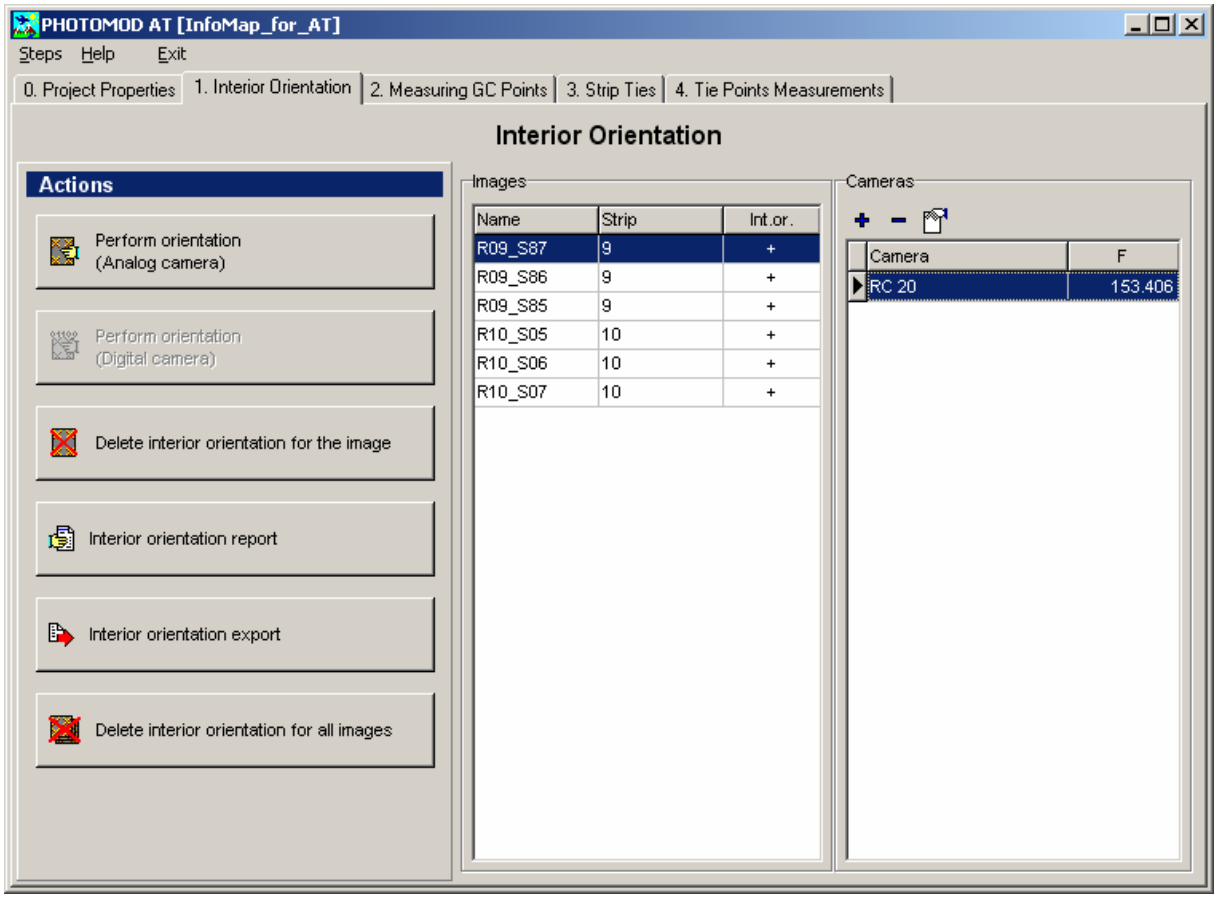
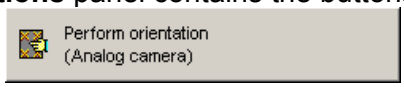
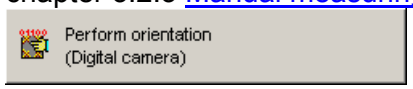
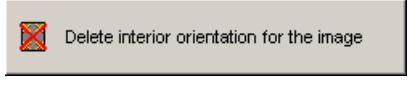


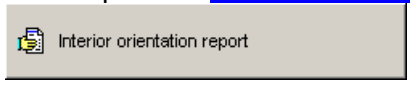
Fig.2 **Interior orientation** tab

Actions panel contains the buttons allowing to perform the following:

- 

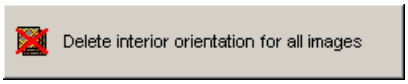
- **Perform orientation (analog camera)** (for the image selected in the list) – opens a window for manual measuring of fiducial marks, see the chapter 3.2.3 Manual measuring of fiducial marks
- 

- **Perform orientation (digital camera)** – opens a window for interior orientation of the projects with digital camera, see the chapter 3.2.5 Interior orientation using digital camera data
- 

- **Delete interior orientation for the image** – deletes the results of the interior orientation for the image selected in the **Images** list on this tab, see the chapter 3.2 Interior orientation
- 

- **Interior orientation report** – opens dialogue for text file name input where the results of images interior orientation will be saved
-

- **Interior orientation export** – opens a window for selection a folder and target file name to save interior orientation results

- 

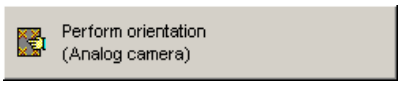
- **Delete interior orientation for all images** – deletes the results of the interior orientation for all of the images in the **Images** list on this tab.

The **Interior orientation** page contains two lists: **Images** and **Cameras**. The **Images** list shows names of the images and strips. The column **Int or.** (interior orientation) indicates whether the image was oriented ("**+**") or not ("**-**") or shows the result of interior orientation. The **Cameras** list shows the cameras used in the current project. You could add cameras to the project from "Cameras catalogue" (see also **PHOTOMOD Montage Desktop** User manual).

The buttons above the cameras list are used for the following:

- - **Add camera** – opens a dialogue to select camera's database and allows then to select new camera in it. After that camera name will be added to camera's list on **Interior orientation** tab
- - **Delete camera** – allows to delete camera selected in the **Cameras** list on **Interior orientation** tab, at that all fiducial marks measurements will be deleted
- - **Camera information** – opens a window to display information about camera selected in the **Cameras** list on **Interior orientation** tab.

3.2.3 Manual measuring of fiducial marks

To measure fiducial marks and calculate orientation, click the 

icon on **Interior orientation** tab (or double click the name of the image selected in the images list). The **Interior orientation** window appears (Fig.3).

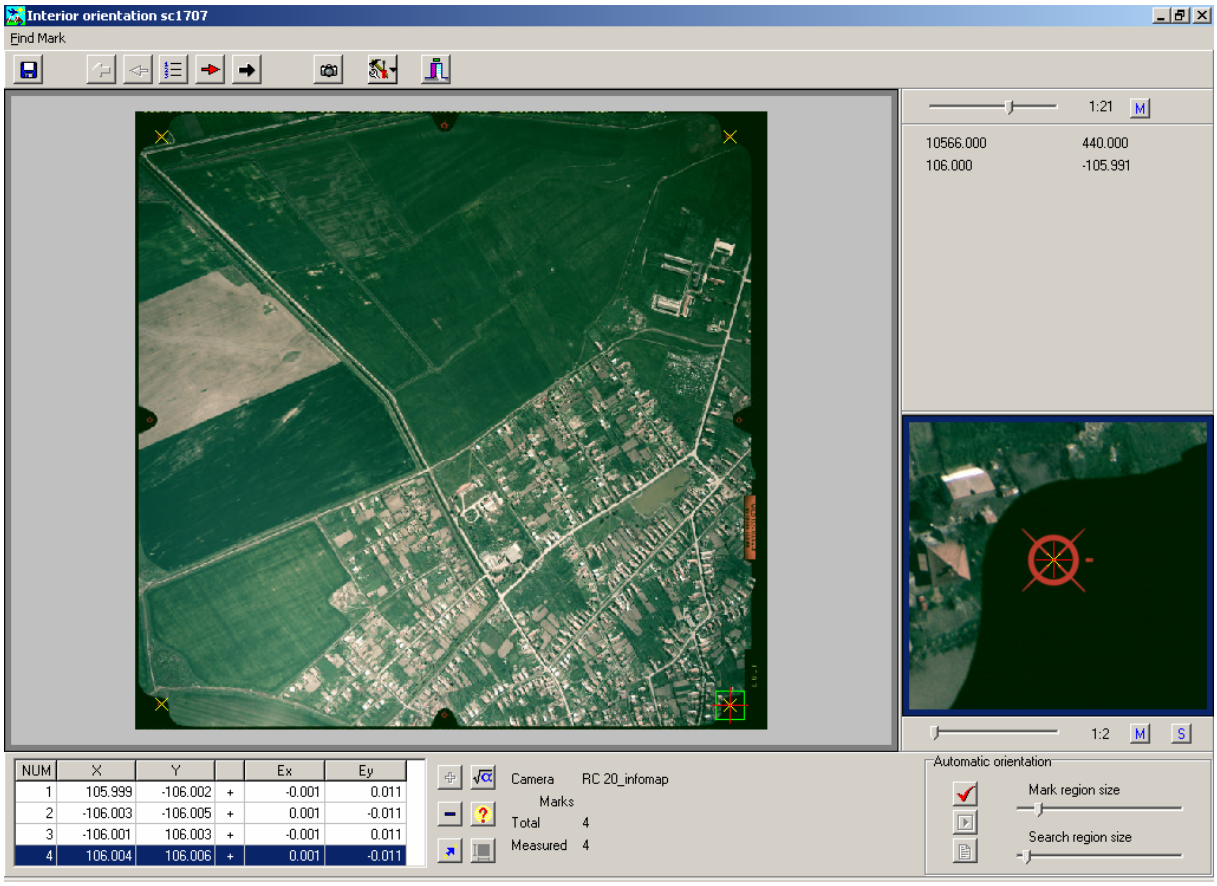


Fig.3 Fiducial marks measuring

The icons at the upper part of the window allow to perform the following operations:

- **Save results** – to save the interior orientation results,
- **Prev. image**, **Next image** – to switch to the previous or the next image of the strip,
- **Prev. unprocessed image**, **Next unprocessed image** – to switch to the previous or the next unmeasured images of the strip,
- **Select image** – to select any of the block images,
- **Camera selection** – to select a camera form the camera database,
- **Options** opens a pop-down menu allowing to adjust the following parameters:
  - image brightness and contrast (see the chapter 3.5.2 Adjusting brightness and contrast)
  - marker parameters (see the chapter 3.5.3 Marker parameters)
  - fiducial marks color
  - show/hide fiducial marks of the image
  - show/hide RGB value (shown in brackets above the profile window)
  - show/hide profile window (rightward from the image)
    Profile window allows to position a marker on the image with high precision. You can locate marker horizontally (turn on horizontal profile) or vertically (turn on vertical).
- **Done** – to exit from interior orientation procedure.

The icons in the lower part of the window are used to perform the following operations:

- **Measure** – to fix the marker position as the measurement of the current fiducial mark,
- **Delete** – to delete the measurement of the current fiducial mark,
- **Move** – to fix the current marker position as the new measurement of the current fiducial mark,
- **Perform interior orientation** – to calculate the parameters of the transformation from film coordinate system to the digital image coordinate system.
- **Scanning resolution** – to specify scanning resolution of the image. It is used if the camera interior orientation parameters were entered as a principal point position (see **PHOTOMOD Montage Desktop** User Manual, chapter “Catalog of cameras”).
- **Status** – opens a window to show the image scanning resolution.

At the lower right corner of the window there is a panel **Automatic orientation** used to perform the interior orientation automatically (see the chapter 3.2.4 Automatic interior orientation).

The procedure of fiducial marks measurements and interior orientation calculation

During interior orientation the table with the X, Y coordinates of the fiducial marks are shown at the lower part of the window (Fig.3). The “**+**“ or “**-**“ sign in the third column of the table shows whether the given fiducial mark has been already measured or not. At the last two columns of the table the residual errors Ex, Ey of fiducial marks coordinates are displayed. These residuals are calculated using the transformation from the image coordinate system to

the film coordinate system found as a result of interior orientation. Ex, Ey are calculated and shown only for cameras with known fiducial marks coordinates.

To measure a fiducial mark, select it in the table and position the marker exactly at the measured mark in the **Lens** window (see the chapter 3.5 Working with raster images for details). To apply the measurement, click the icon or press the "**+**" key on the NumPad.

Once first two or more fiducial marks have been measured the marker is automatically positioned approximately at the 3-d and subsequent fiducial marks when they are selected in the table. After that you can use **Ctrl-F** hot keys (or the button **Find mark** in upper window menu) to place marker into closest fiducial mark position.

To get fiducial marks measured, click the button to calculate the transformation. The **Transformation type** dialog box appears where you can select one of the following transformation types:

- **Helmert**;
- **Affine**;
- **Projective**.

Selecting particular type depends on available fiducial marks data (see the beginning of this chapter).
See also the chapter 3.2.1 Coordinates transformation.
As a result of interior orientation a window with errors by X and Y axes appears. The error units (usually mm) correspond to the units selected while entering camera parameters.

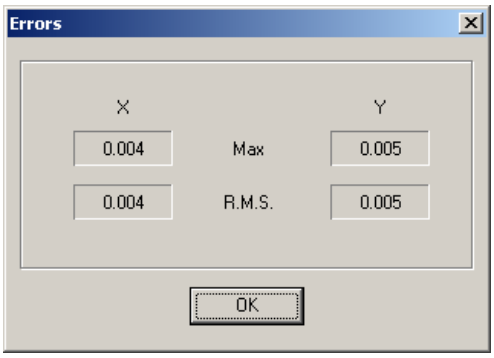


Fig.4 Interior orientation errors

Once interior orientation for the current image is done you should save the results by pushing the icon (in upper button bar of **Interior orientation** window) and move to the next unmeasured image using the icon.

If calibrated distances were input in camera data, the icon is disabled. You can control fiducial marks measuring, using a panel with the last results of image interior orientation procedure (opened by the icon).

When at least one of the block images is processed manually and has interior orientation results, you can perform interior orientation for the rest of images automatically, see the chapter 3.2.4 Automatic interior orientation.

3.2.4 Automatic interior orientation

Before starting automatic interior orientation process you must perform the interior orientation "manually" at least for one image (see the chapter 3.2.3 Manual measuring of fiducial marks).

Click on the icon in **Automatic orientation** panel to activate automatic interior orientation mode. Then setup 2 parameters – **Mark region size** and **Search region size** using corresponding sliders. As a result the system creates “templates“ for each manually measured fiducial mark. The size of template is defined by *Mark region size.* Automatic orientation process searches fiducial marks using these templates on all images inside of selected *Search regions.* Search region size should be big enough to “cover“ fiducial mark area especially in cases of cutting or scanning film differently (when corresponding fiducial marks are located at different distances from the image edge). *Mark region* must include the mark completely (see Fig.5). *Search region* and *Mask region* are displayed by rectangles in the “lens“ window and in the main view window as well.

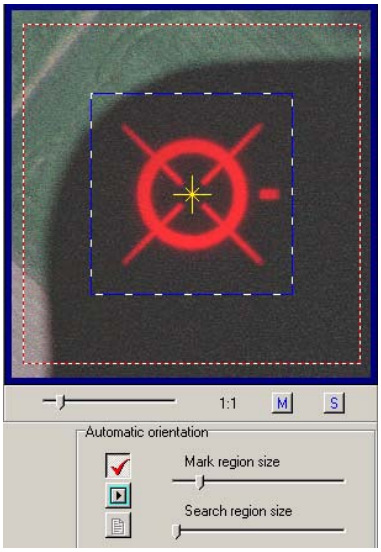


Fig.5 Automatic interior orientation parameters

When process parameters are selected, click an icon **Perform automatic orientation** ( ) and get **Automatic interior orientation** window open (Fig.6).

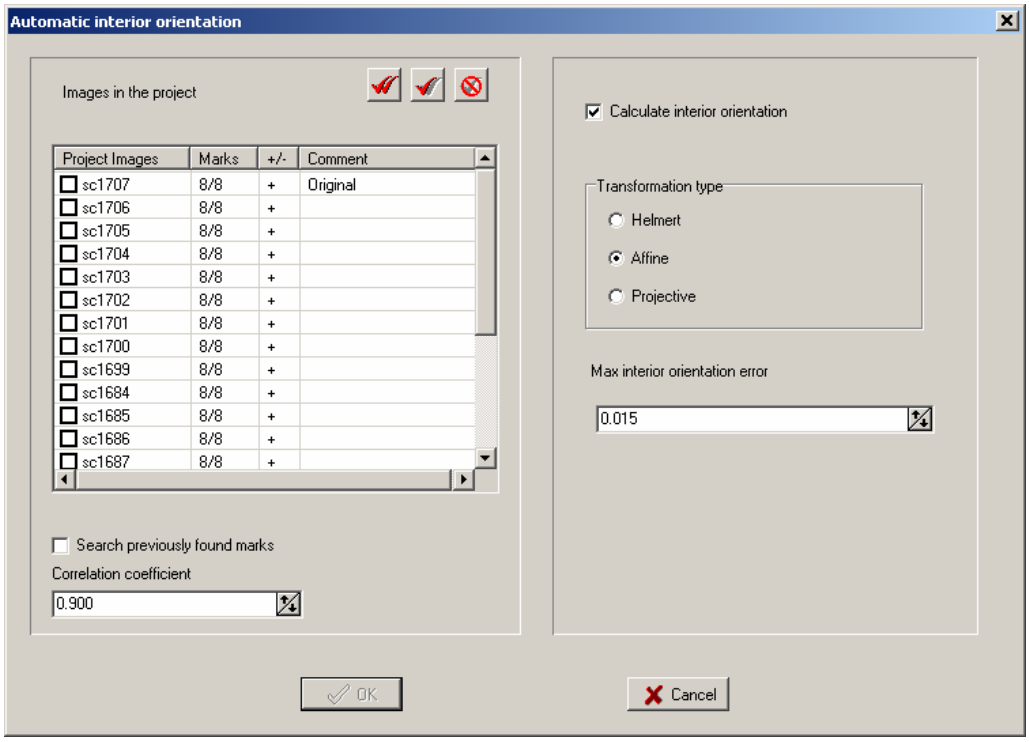


Fig.6 Automatic interior orientation window

Left part of window contains a list of project images. Use check boxes at the left side of the image name to select an image to make the interior orientation for icons at the top of window are used to:

- - **select all** – select all images in the list which supposed to pass interior orientation automatically using as a sample fiducial marks measured manually
- - **select unprocessed** – select images that are not processed yet
- - **unselect** – cancels images selection in the list

An image that was oriented “manually“ is a reference image and is marked in the list as **Original** (in the **Comment** column). **Marks** column displays number of found marks and total number of marks (measured on the Original image) delimited by slash. An option **Search previously found marks** is used to search all marks (including already found ones) every time you start the process. The system is looking for fiducial marks using a correlation process, which compares a mark image with a template. The correlation coefficient threshold is set in a **Correlation coefficient** text field (0.9 by default). Use **Max interior orientation error** parameter to set maximum acceptable error calculated on a mark to consider it as “found“. See the description of transformation types and errors (right part of window) in the chapter 3.2.3 Manual measuring of fiducial marks.

After selecting process parameters push **OK** button to start interior orientation process. When calculations are done, the window **Automatic interior orientation results** is opened (also opens by clicking the icon on **Automatic orientation** panel, see Fig.5). This window contains a list of images and values of interior orientation errors for each of them. There is also a column of correlation coefficient values. If you are not satisfied with errors or some fiducial marks are not found, you can resize mark and search regions and start the process another time. You can also select any image and push the **Goto** button to make measurements manually.

You should consider a **Strip orientation** option (**Forward** or **Revert**) when making the interior orientation automatically. Strip orientation is setup in **PHOTOMOD Montage Desktop** module on **Block forming** stage, see an appropriate User Manual.

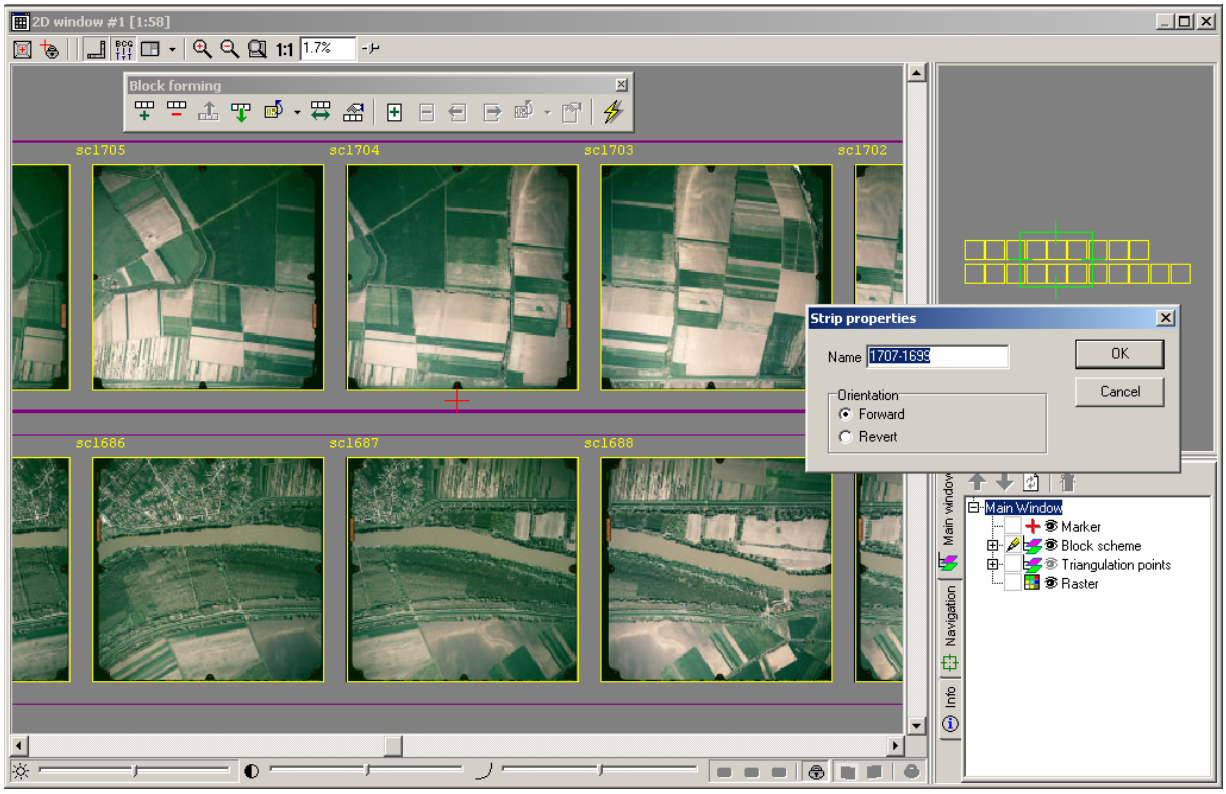


Fig.7 Sample of forward and revert strip orientations

Figure 7 shows a sample of forward and revert strip orientations caused by opposite courses of the aircraft. In this case the strip orientation should be set as “forward“ for the first strip and “revert“ for the second one (or vice versa). On this sample you can easily define the opposite strip orientations by special red mark with camera parameters printed in . Or by taking a look of corresponding fiducial marks – the 1st fiducial mark is located at the lower right corner on the “upper“ strip of images and at the upper left corner on the “lower“ strip of images.

Note. Image rotation (see PHOTOMOD Montage Desktop User Manual) makes no influence on the strip orientation

3.2.5 Interior orientation using digital camera data

When processing data acquired by digital camera you should input its parameters and remember that all of them (principal point coordinates, distortion coefficients, focal length) should be input in the same units – either pixels or millimeters. There is an appropriate panel in **Cameras editor** window (see **PHOTOMOD Montage Desktop** User Manual) where you can choose proper units. In most cases all parameters of calibrated digital cameras included into camera passport are in the same units. Otherwise you should recalculate them. For instance, if pixel size of camera matrix is known, you can convert camera focal length from millimeters into pixels.

Interior orientation of the image acquired by the digital camera means measuring of principal point location regarding to **left lower pixel** of the image. Its coordinates in **Camera editor** are input as follows: X=Shift from lower left pixel in X axis, Y= Shift from lower left pixel in Y axis. The shifts should be calculated according to camera passport data. Symmetry point coordinates used to consider distortion are also input as shift from left lower pixel in X and Y axis.

Note: When importing exterior orientation parameters, make sure that the camera X axis direction set in the PHOTOMOD project coincides with the flight direction.

The example below shows digital camera (DSS) parameters input and further image interior orientation workflow.

DSS Camera passport

Table 1. Camera Calibrated Parameters

Parameter	Value
f (mm)	55.2205
Pixel Non-squareness	1.0
x_{PP} *(pixels)* [+]	2068.27
y_{PP} *(pixels)* [+]	2036.74
x_{PP}^{C} *(mm)* [++]	0.2679
y_{PP}^{C} *(mm)* [++]	0.0833

[+] x_{PP} and y_{PP} are measured from image upper left corner, (image size 4077x4092), see Fig.8
[++] x_{PP}^{C} and y_{PP}^{C} are measured from image center (pixel size = 9 microns), see Fig.8

Table 2. Radial Lens Distortion Table

Radial Distance (mm)	Radial Distortion (Pixel)	Radial Distortion (microns)
2	-0.02	-0.18
4	-0.16	-1.46
6	-0.55	-4.92
8	-1.29	-11.65
10	-2.52	-22.70
12	-4.44	-39.04
14	-6.84	-61.52
16	-10.09	-90.77
18	-14.12	-127.08
20	-18.91	-170.23
22	-24.46	-219.27
24	-30.25	-272.28
26	-36.23	-326.04

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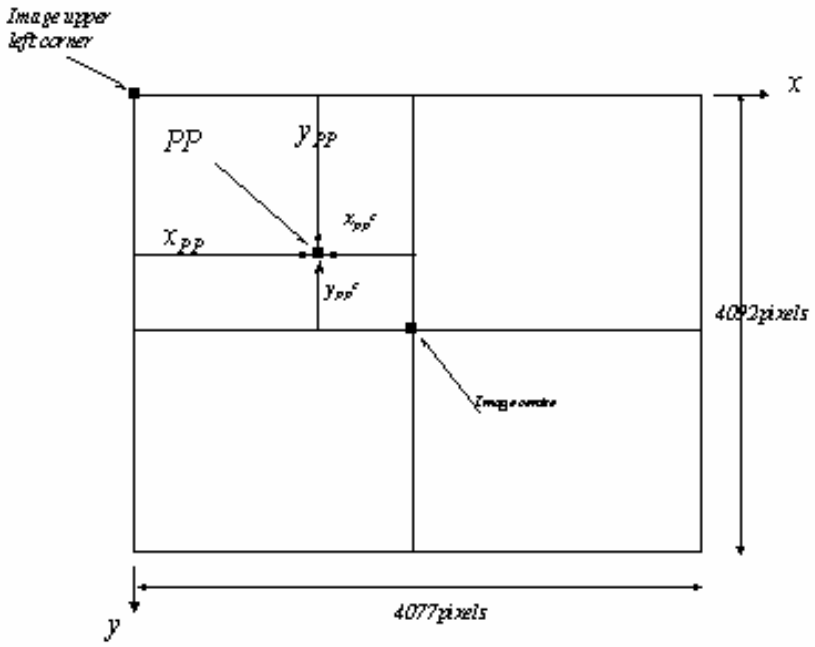

Remarks:
X^i and Y^i: Image Coordinate Frame – **Right** Handed System
X^P and Y^P: Pixel/Monitor Coordinate Frame – **Left** Handed System

Fig.8 Principal Point Offsets in a DSS Digital Image

Note. In given example, symmetry point (with zero distortion) coincides with the principal point

In **Cameras editor** window (Fig.9) the following values were input:

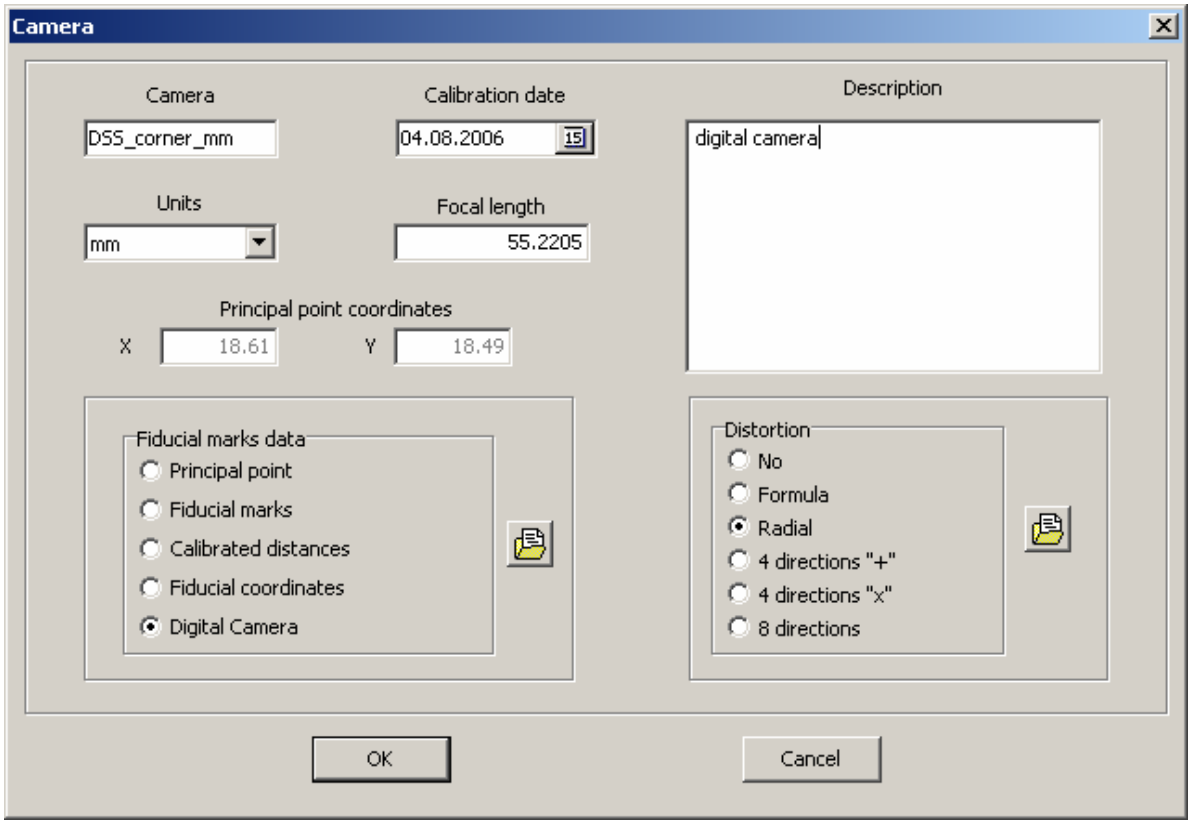

Fig.9 Cameras editor

- Units – **mm**
- Fiducial marks data – **Principal point**
- Focal length – **55.2205 mm**

When the option **Digital camera** is selected, push the button which opens the following window, intended for input of digital camera parameters:

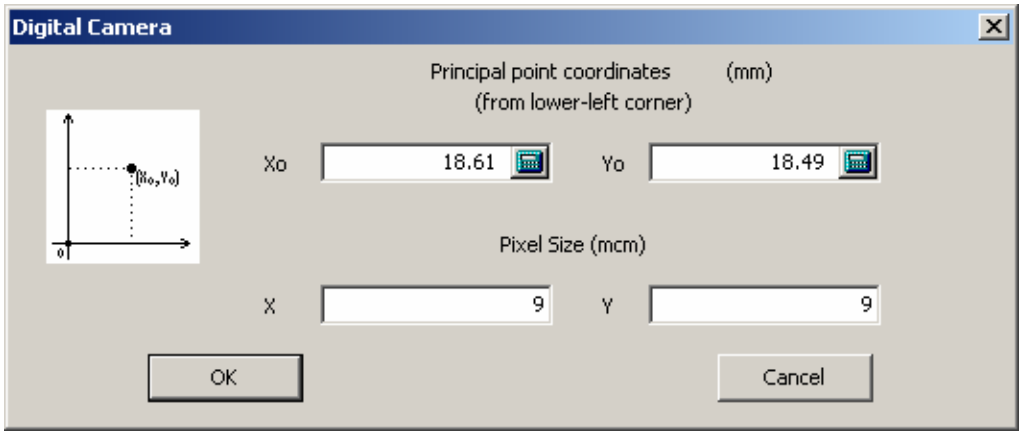

Fig.10

- Principal point coordinates

Xo = Xpp * (pixel size in mm) = 2068.27*0.009 = **18.6144 mm**
Yo = ((pixels number on Y axis) – Ypp – 1) * (pixel size in mm) = 2054.26*0.009 = **18.4883 mm**

- Symmetry point (with zero distortion) coordinates are the same as principal points coordinates **X=18.6144 mm, Y=18.4883 mm**

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- Radial distortion in **millimeters** are input in the window (Fig.11), opened by the button , if in **Distortion** field the option **Radial** is selected:

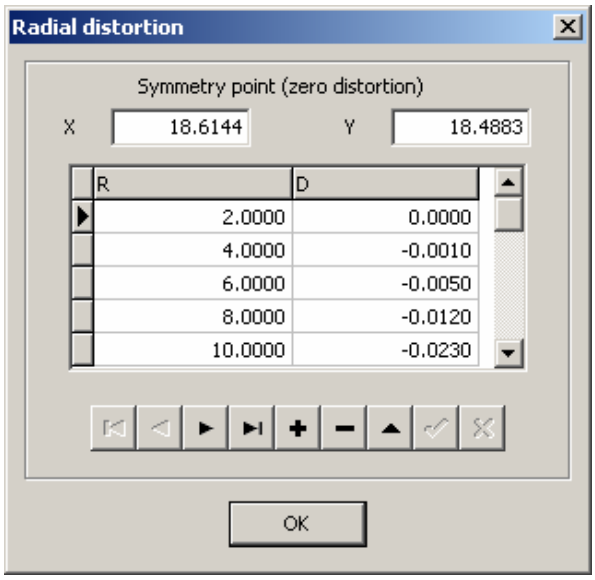
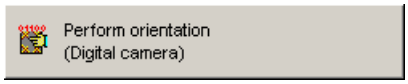


Fig.11 Radial distortion

Note. PHOTOMOD system takes into account a distortion as follows: a point position on an "ideal" (free of distortion) image is equal to its position on the real image PLUS the value from the distortion table. You should input passport data carefully since there is no common rule for distortion signs and they could be opposite for some cameras passports. Thus, in case of poor results of block adjustment you should try to input distortion coefficients with the opposite sign

Push the button 

Perform orientation (digital camera) to perform interior orientation. In the window opened push the icon **Auto** and the button **OK**. After that you will get the results of interior orientation considering possible images' rotations during project creation in **PHOTOMOD Montage Desktop** module. Fig.12 shows (by location of coordinate axes on blue icons to the right from images names), that images of 4th strip were rotated on 90 degrees, and images of 3rd strip – on 270.

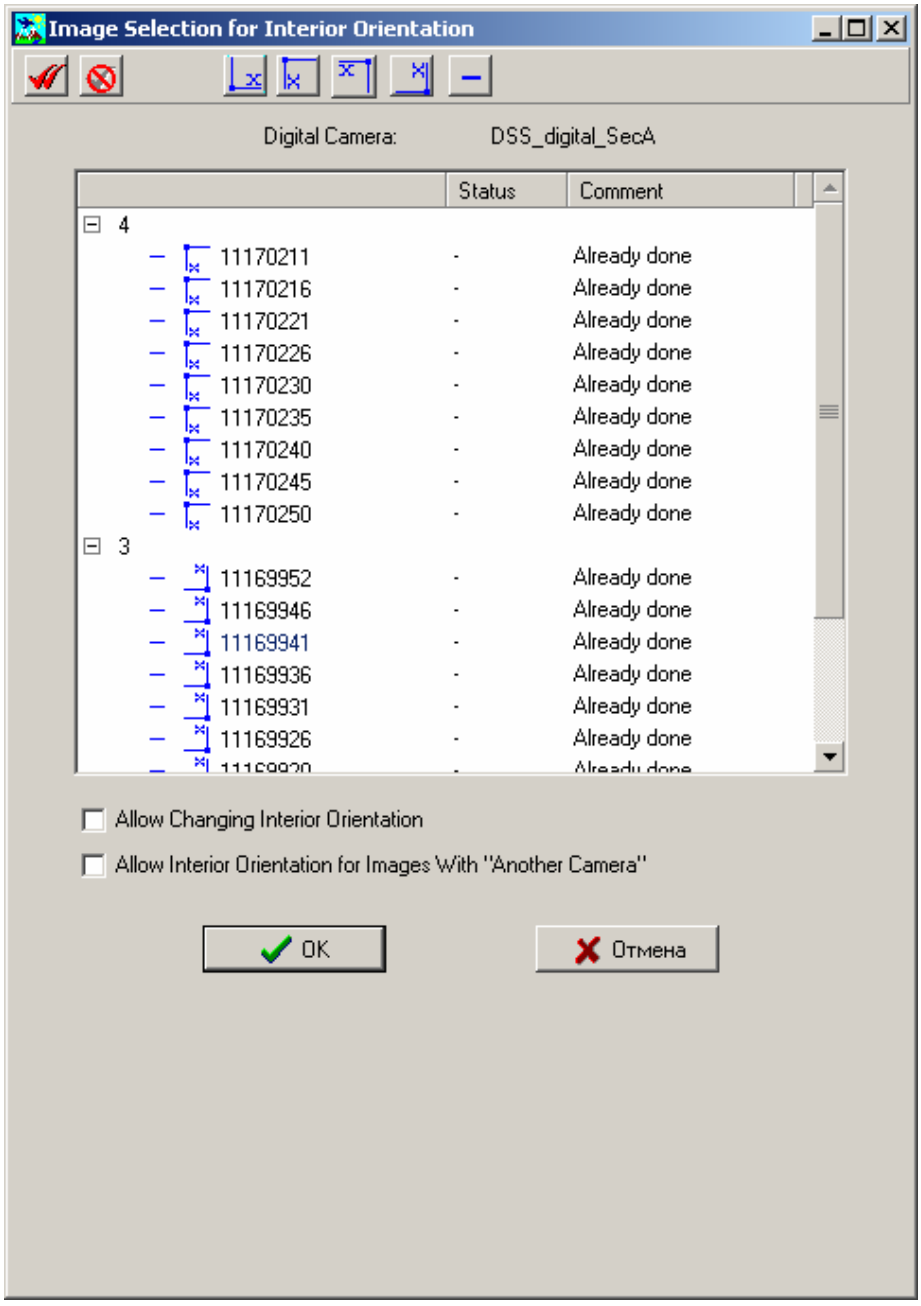


Fig.12

The icons with blue coordinate axes in upper part of the window are used when it is necessary to change coordinate system for some selected images or strips. Make selection using standard OS Windows tools – **left mouse button + Shift, Ctrl**.

See the example of coordinate system change (X and Y axes direction) for group of selected images on Fig.13. Please note, that in vast majority of cases it is not necessary to change the coordinate system for individual images.

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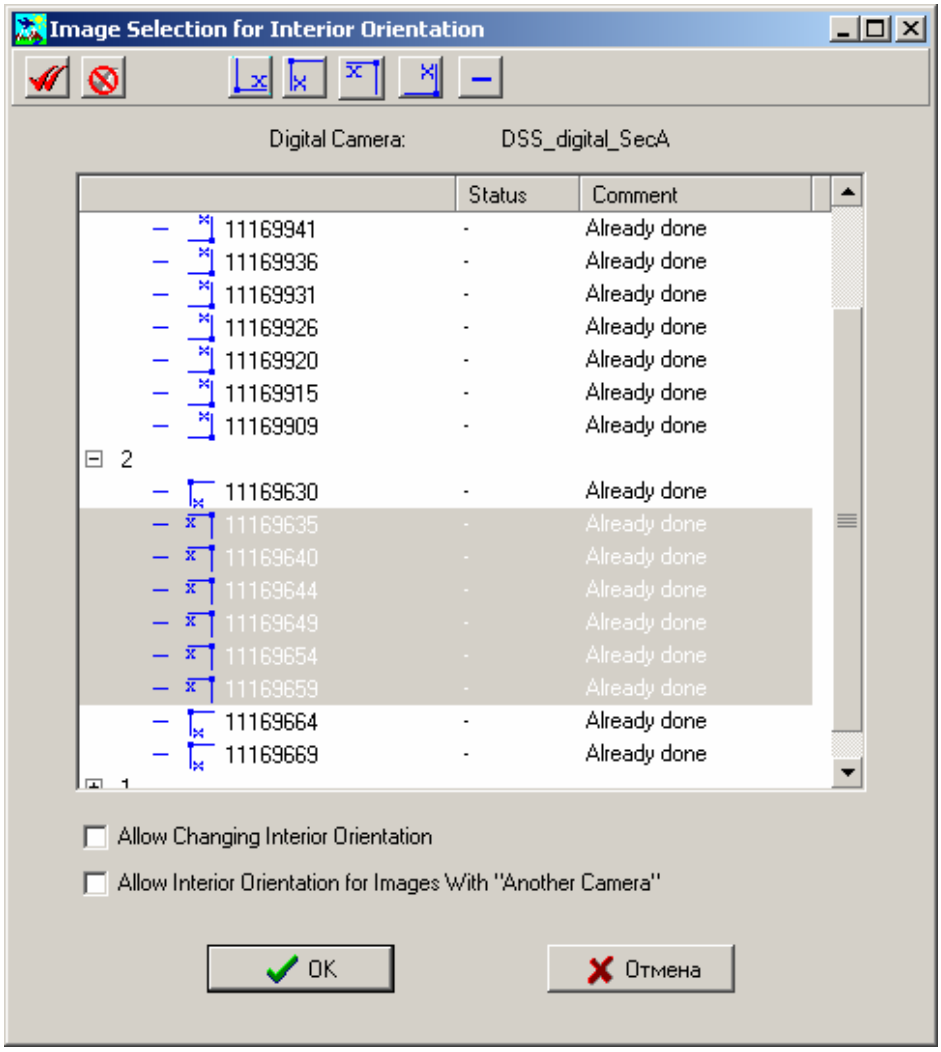
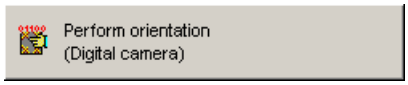


Fig.13

Turn the option **Allow changing interior orientation** on if it is necessary to change coordinate system for selected images / strips.

Turn the option **Allow interior orientation for images with "another camera"** on if it is necessary to change interior orientation for the images, attached to wrong camera accidentally (in general case project could contain images acquired by different cameras).

After pushing the button 

Perform orientation (digital camera) interior orientation results are shown. Fig.14 shows the first image of the 4th strip.

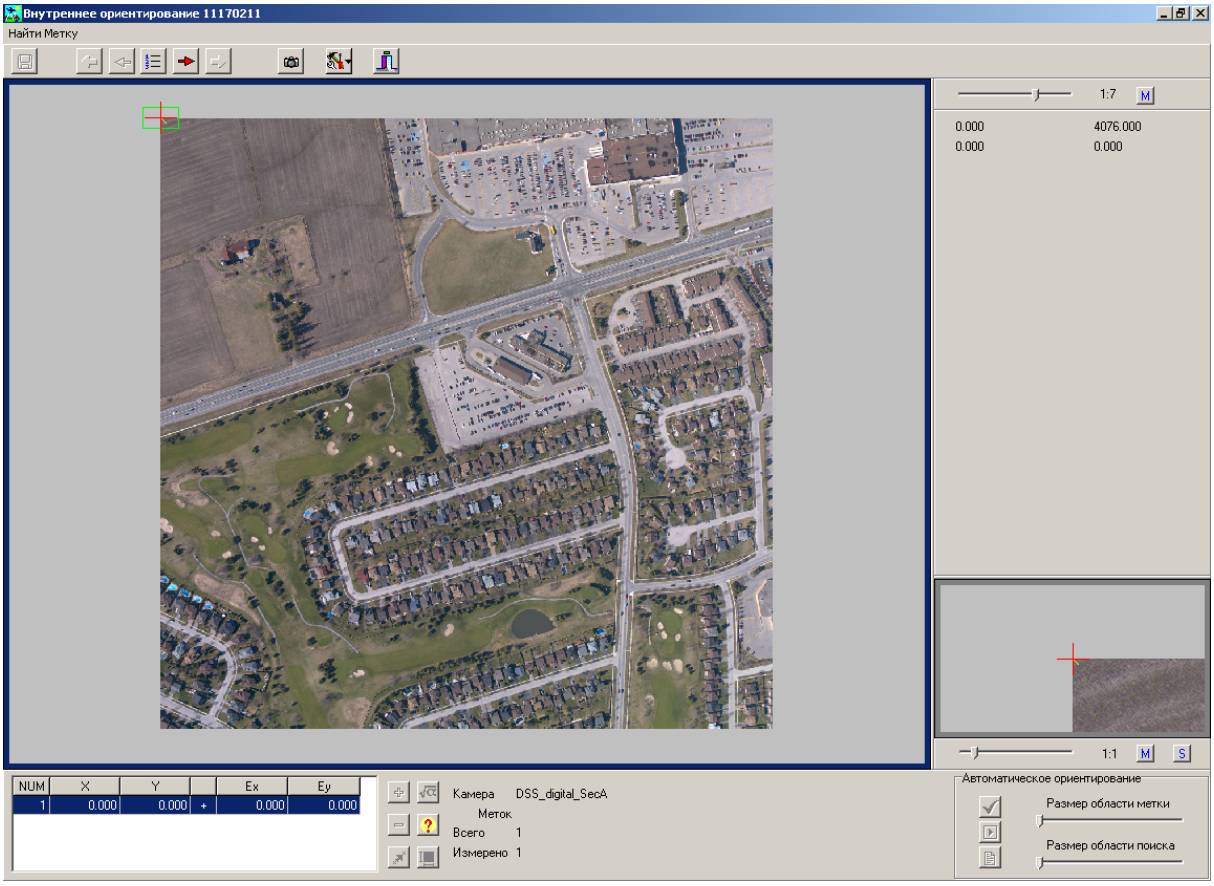


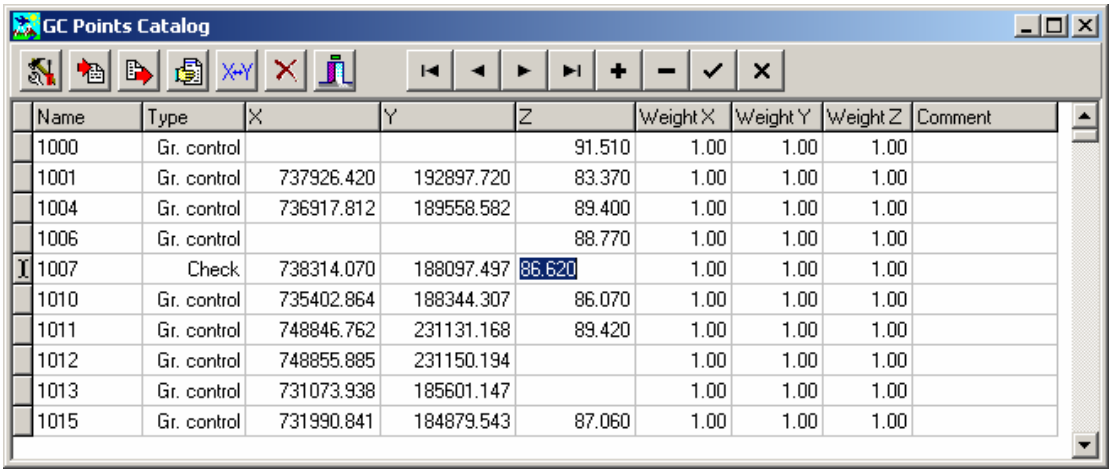
Fig.14

3.3 *Ground control points input*

Select the **Measuring GC points** tab of **PHOTOMOD AT** window to input ground control points (Fig.17). At first you should enter catalog of control points coordinates (see the chapter 3.3.1 Entering ground control points coordinates) and then recognize and measure GCP on the block images (the chapter 3.3.2 Measuring of ground control points).

3.3.1 Entering ground control points coordinates

Click the icon (**GCP catalog**) to open a window for input GCP coordinates. To add a new point to the list click the icon. For each point enter a point name (**Name** field), its X, Y, Z coordinates (**X**, **Y**, **Z** fields) and optionally weight values for each coordinate (**Weight X**, **Weight Y**, **Weight Z** fields). The **Type** field is used to set the type for a point – **Control** (default type) or **Check**. Control points are used for the block adjustment and check points are used to check the adjustment accuracy. See also **PHOTOMOD Solver** User Manual. Control points may be represented by XY and Z coordinates. If some point has no plain (X, Y) or height (Z) coordinates, leave the appropriate field blank. At that after export to text file these blank fields will be substituted by "*****" symbol (see the chapter 3.3.1.1 GCP file format). When GCP coordinate values are added, you can select the value you need by single mouse click and edit it.



Name	Type	X	Y	Z	Weight X	Weight Y	Weight Z	Comment
1000	Gr. control			91.510	1.00	1.00	1.00	
1001	Gr. control	737926.420	192897.720	83.370	1.00	1.00	1.00	
1004	Gr. control	736917.812	189558.582	89.400	1.00	1.00	1.00	
1006	Gr. control			88.770	1.00	1.00	1.00	
1007	Check	738314.070	188097.497	86.620	1.00	1.00	1.00	
1010	Gr. control	735402.864	188344.307	86.070	1.00	1.00	1.00	
1011	Gr. control	748846.762	231131.168	89.420	1.00	1.00	1.00	
1012	Gr. control	748855.885	231150.194		1.00	1.00	1.00	
1013	Gr. control	731073.938	185601.147		1.00	1.00	1.00	
1015	Gr. control	731990.841	184879.543	87.060	1.00	1.00	1.00	

Fig.15 GCP coordinates input

Besides entering coordinate values from keyboard, you can import them from a text file (see the chapter 3.3.1.1 GCP file format).

The icons of upper panel of GCP catalog window are used for the following operations:

- - settings for points (ground control and tie) numbering – opens a window used to setup a rule of numeration of GC and tie points, that will be added to project. The number input will be added to the beginning of point name
- - import GCP list from txt file
- - export GCP list to txt file
- - create report – opens a window containing results of GCP coordinates input, and used for editing, printing or saving the catalog to text file
- - swap X and Y values
- - clear GCP catalog – allows to delete all points from catalog
- - exit
- - first record
- - previous record
- - next record
- - last record
- - add point
- - delete record
- - confirm point adding
- - cancel edit

If you have GCP catalog in text file you can import it. Click the icon (**Import**) and select the file with GCP catalog in the dialog box. File format is described in the chapter 3.3.1.1 GCP file format. If the GCP file is opened successfully, the window with the list of GCP appears.

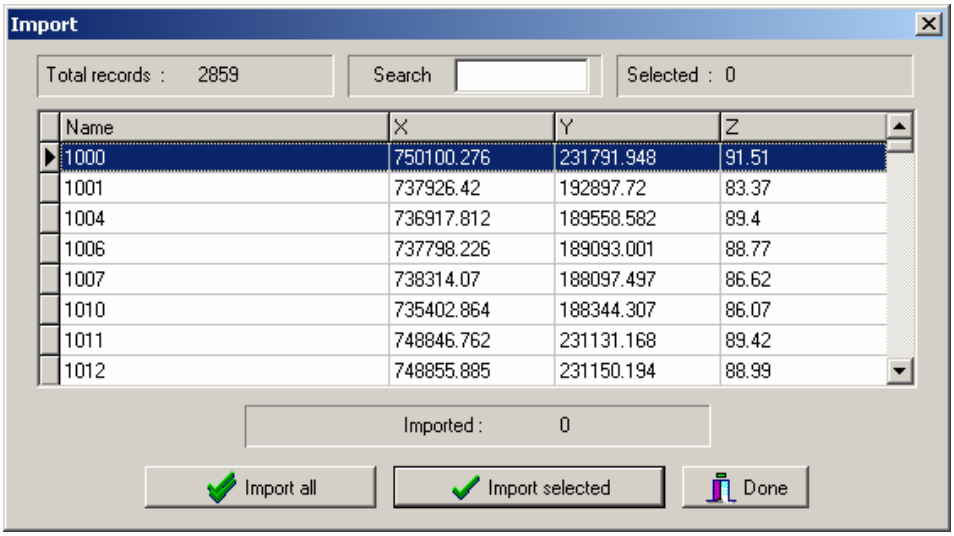


Fig.16 GCP coordinates import

To import points you want, select them using the mouse along with pressed **Ctrl** key or "arrow" keys along with pressed **Shift** key. Once points are selected, click the button **Import selected**. You can also add all points from the file by clicking the button **Import all**. Imported points are added to the end of GCP list, and points of the same name as existing ones will be renamed with adding 0 number to the end of their names.

The icon (**Export**) is used to export coordinate values to the selected text file. The output file format is described in the chapter 3.3.1.1 GCP file format.

After deleting control point from the list, it is completely deleted if it is measured just on one image and it becomes a tie point if it is measured on more than one image (see the chapter 3.4.2 Tie points measurements).

If you have coordinates of the images ***projection centers*** you can use them for block adjustment (see **PHOTOMOD Solver** User Manual). Click the icon (**projection centers**) to open a window of input or import projection centers coordinates. The projection centers window contents is the same as described above for the ground control points. The names of projection centers should be equal to the names of corresponding images.

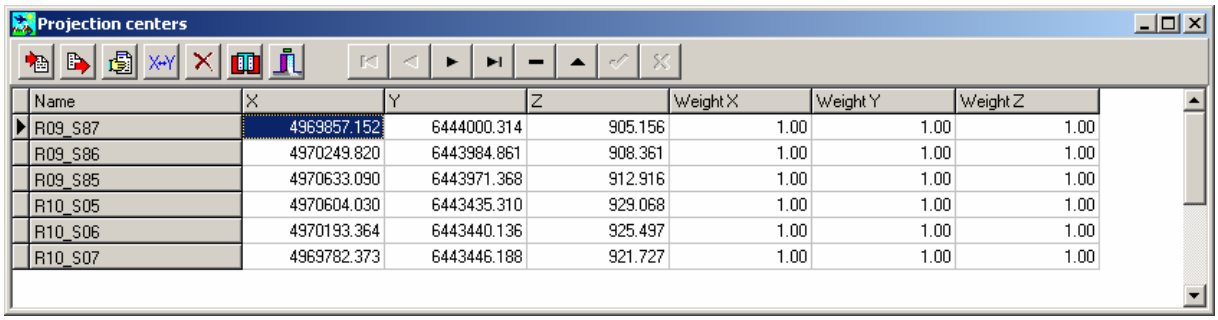


Fig.17 Projection centers catalogue

Tools for projection centers input, editing, and import are the same as for GCP catalogue. You can use projection centers coordinates for relative orientation of images block by pushing the button (**Make block scheme using projection centers**), then in the window opened input average height of terrain and push **OK**. The block scheme created is

shown after pushing the button

(**Show scheme**) on **Strip ties** and **Tie points measurements** tabs, see the chapter 3.4.4 Working with block scheme.

Block scheme created is also considered at automatic search and measurement of tie points in **PHOTOMOD AAT** module, see corresponding User Manual.

Note. For airborne images block adjustment minimum acceptable number of ground control points is 3. Every point should be measured on at least 2 images on stages of strip ties and images tie points measurements (see the chapters 3.4.1 Interstrip ties u 3.4.2 Tie points measurements). About number of GCP for scanner images blocks adjustment see the chapter 4.1 Number of GCP necessary for space images processing in PHOTOMOD

Note. GCP coordinates are given in the coordinate system selected, during project creation in PHOTOMOD Montage Desktop module (see corresponding User Manual)

3.3.1.1 *GCP file format*

A GCP file consists of strings of the following structure:

Name, **X**, **Y**, **Z**, **Weight X**, **Weight Y**, **Weight Z**, **Comment**,

where **name** – the name of a point, **X Y Z** – ground coordinates of this point, **Weight X**, **Weight Y**, **Weight Z** – weight values of each coordinate. The following symbols can be used as delimiters: “space“, “tab“, “**:**“ or comma. If some coordinates values are unavailable, the “*****“ symbol must be written instead of missing value. If a point name contains “space“ symbol, the “**:**“ symbol must be used as a delimiter.
The example of GCP catalogue is shown below:

Ground control points.txt
1244,*,*,811.84
724,39348.83,6283.30,815.10
750,39932.36,6180.48,831.81
440,39435.71,5996.73,*
436,39573.30,6270.77,810.32
748,39753.11,6650.94,*
117,39556.14,6886.47,822.08
1355,*,*,820.12

3.3.2 Measuring of ground control points

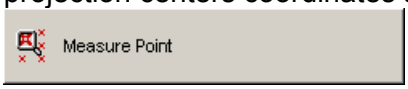
After GCPs coordinates input you should recognize and measure ground control points on the images. The **Measuring GC points** tab contains two lists: **Images** showing the names of the images with their strips and **GC points** showing the contents of the GCP catalog. The column “**+/-**“ of the **GC points** list shows whether a point has been already measured on some image. If a point has been measured the “**+/-**“ column displays the corresponding image name.

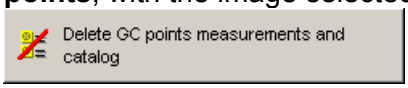
Actions panel contains the buttons allowing to perform the following:

-

GC points catalog – opens a window to input GCP coordinates, see the chapter 3.3.1 Entering ground control points coordinates

-

Projection centers – opens a window to input images projection centers coordinates as ground control points
- 

Measure point – opens the window **Measuring GC points**, with the image selected in the **Images** list to measure ground control points there
- 

Delete GC points measurements and catalog – deletes GC measurements (see the chapter 3.3.1 Entering ground control points coordinates).

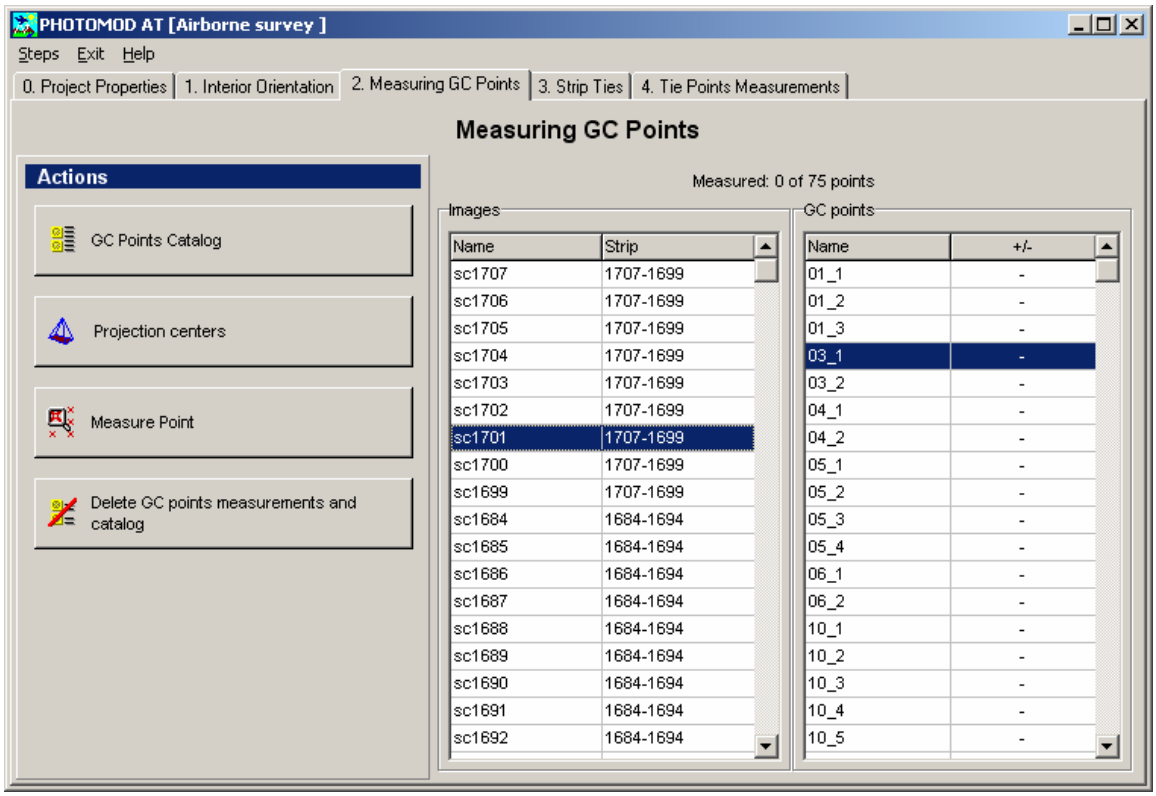


Fig.18 Measuring GCP tab

To measure control points select the image in the **Images** list, where you want to measure points. Then push the icon (**Measure point**) to open a window with a selected image.

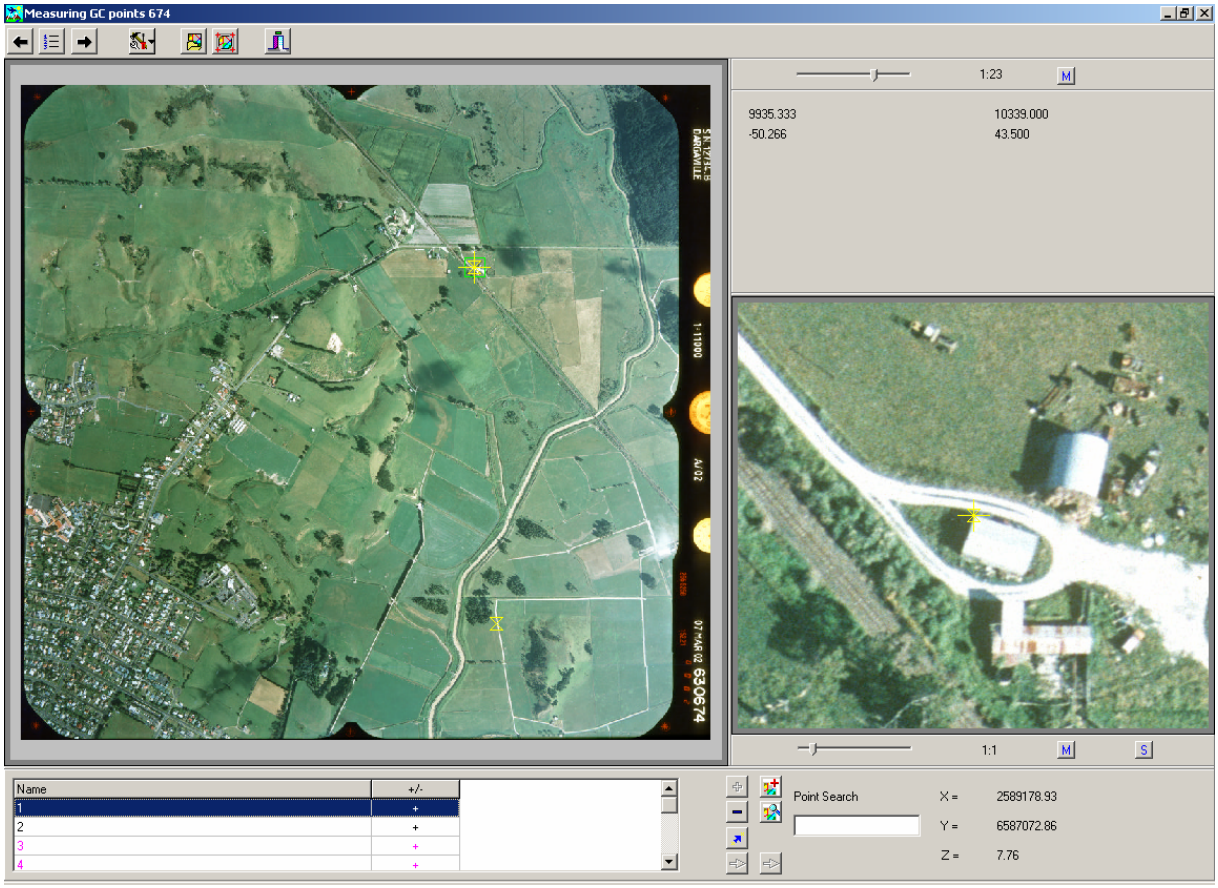


Fig.19 Measuring of ground control points

Ground control points must be identified and measured on one of the strip images only. If a point is imaged on more than one image it can be measured (transferred) to these images at steps 3 (**Strip ties**) and 4 (**Tie points measurements**).

To measure a point on an image use the marker manipulations described in the chapter 3.5 Working with raster images.

Note. Measuring GCP in the stereo mode becomes available when relative orientation is completed. See the chapter 3.4.2 Tie points measurements

To measure the ground control point on the image:

- select the point name in the list in the lower left part of the window, using the mouse or “arrow“ keys of the keyboard,
- position the marker exactly on the ground control point on the image,
- apply the measurement by pushing the button.

To re-measure the point (change its position on the image):

- select the point in the list,
- move the marker to a new position,
- push the button to apply the change.

To delete a point that has been already measured:

- select the point in the list,
- push the button.

The points measured on other images are indicated in the list by the pink color. To move to the image where such point has been measured, push the button (**Go to image…**). If the point is not measured and is located on the image, which is not shown in the window, push the button (**Search image on the block**), and go to the image, which contains the point to measure it. Such transfer is possible (and the button is active), if images of the block are matched to each other (for example automatically in **PHOTOMOD AAT** module), and also the block scheme is created and saved, see the chapter 3.4.4 Working with the block scheme.

When two new points are measured, selecting the third and following points in the list leads to automatic positioning of the marker to the surrounding of selected point.

Note: If during adding an image to scanner project, coordinates of the image corners had been also read, than the marker is automatically moved to the approximate position of the given point on the images. Otherwise preliminary positioning is done after three points have been measured on the image. In case the calculated approximate position falls outside the image, the marker stays on its previous place.

You can enter point's name (or number) to **Point search** field and appropriate record will be highlighted in the point's list.

To continue measuring points on other images of the block, use the following buttons:
, - move to the next/previous image of the strip,
- select any image of the block.

To view an image "under" control point there is an option **Options** ( ) **| Show points**. If this option is off, control points are not displayed.

Another way to obtain ground control points coordinates is to use scanned and georeferenced map, which was created for the same territory as space or airborne imagery. More details about raster map georeferencing see in chapter 3.3.2.1 Raster map georeference, and about point's coordinates measurements on the map, see the chapter 3.3.2.2 Measuring points on raster map.

3.3.2.1 *Raster map georeference*

For ground control point's coordinates acquisition is helpful to use scanned and georeferenced topographic map on the same terrain, where aerial and space images were acquired. Scanned map (in TIFF, BMP, JPG formats) could be georeferenced using ground control points coordinates in **PHOTOMOD Montage Desktop** module (see an appropriate manual) or in raster map window opened in the following way:

Push the button (**map georeference**) in the window **Measuring ground control points**, which is available to open on tab 2 (see the chapter 3.3.2 Measuring of ground control points). Then the window for raster map loading appears, where you can georeference the map using known GCP coordinates.

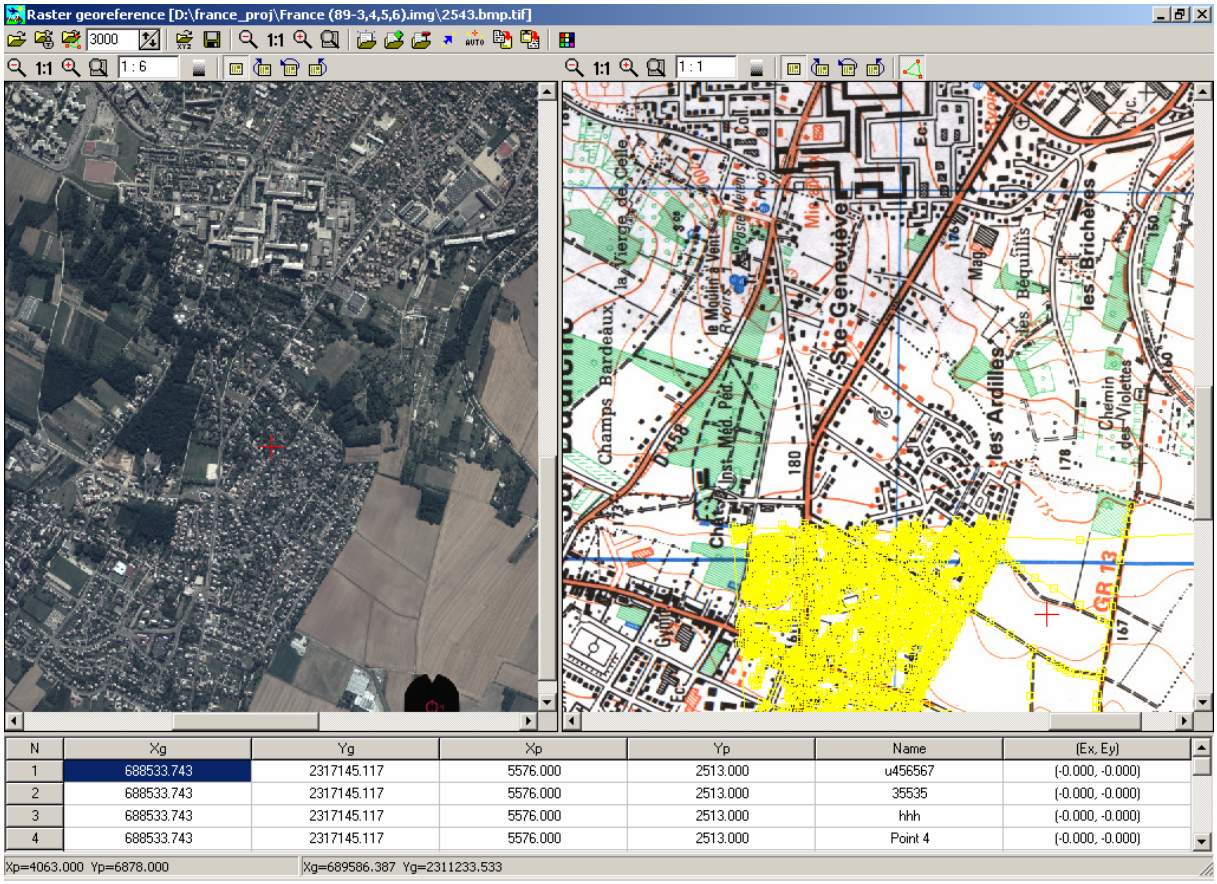


Fig.20 Map georeferencing

If georeference file (in MapInfo TAB format and with the same name as map file) is storing in the same folder as file with scanned map, then list of georeference points and their coordinates is opened in **Raster map** window. In this list Xg, Yg – geodetic coordinates, Xp, Yp – pixel coordinates, Name – point name.

Push the button with point number in leftmost column **N** of the table to visualize point in map window (to place marker in point's pixel coordinates).

Upper menu buttons are intended for the following operations:

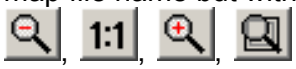
- load raster map – opens dialogue of raster file selection (in TIFF, BMP, JPG formats) and its opening, duplicated by hot keys **Ctrl-O**

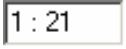
- load reference map – opens dialogue for selection of raster file with map (in main raster formats) and its opening

- load vector map – opens dialogue of vector file selection (in TIFF, BMP, JPG) (in PHR (PHOTOMOD format), DXF or Shape format).

- load XYZ points from file – opens dialogue of coordinates file selection (in TXT format) and opens it as a table below the map window. Point's coordinates could be loaded replacing opened coordinates or in addition to them, after an appropriate warning.

- save – saves georeference file in MapInfo TAB format, at that file name is the same as map file name but with TAB extension.

 - zoom management, duplicated by hot keys usual for **PHOTOMOD** system - **/**, **Alt-1**, *****, **Alt-Enter**

 - shows zoom scale in raster map window

- map displaying in grayscale or color mode

For more convenient work the map could be rotated in the following ways: - without rotation, - turn at 90 degrees, - turn at 180 degrees and - turn at 270 degrees. At that raster file is not changed and the rotation is executed “on the fly“.

- clear – deletes all points (list cleanup)

- add point – measures new point coordinates on the map and adds them to the end of list. At that marker pixel coordinates are assigned to point and 0 value is assigned to geodetic coordinates (you can enter them manually in appropriate cell)

- delete point – deletes the point selected in list, duplicated by hot keys **Ctrl-Del**

- re-measure – replaces pixel coordinates of selected point. At that current pixel coordinates of marker are assigned to the point and saved in the list

- predict – places marker to coordinates of point, selected in the list

- copy coordinates to clipboard – copies coordinates of selected point to clipboard. Coordinates are in the following format "Xp Yp Xg Yg"

- paste coordinates from clipboard – pastes selected point coordinates from the clipboard in the following possible formats: "Xg Yg", "Xg Yg Zg", "Xp Yp Xg Yg", "Xp Yp Zp Xg Yg Zg", where Zp equals 0.

- select color – opens standard OS Windows palette to choose point’s symbol color on the map.

For map georeferencing you should recognize points with known geodetic coordinates on the map. Map could be referenced using only one point (in that case it is considered that measurement unit is 1 pixel and axis coincide. If there are two points, then map will be scaled and rotated, in case of three points affine transformation will be applied), but for accuracy control you should measure not less then 4 points. To measure point put marker on point’s place on the map and push button (add point). After that point’s name and pixel coordinates will be added to the list. Input geodetic coordinates of the point to appropriate cells manually. When fifth point is measured, coordinates measurement errors E_X and E_Y will be automatically calculated and saved to the last columns.

To place marker on the measured point on the image you should click on table cell with point number (in left column).

To edit coordinate value in table cell you should select the cell and press **F2**. To end editing and save coordinate press **Enter**, to exit from editing without coordinate save press **Esc**.

When georeference is completed push the button (**save**) to save georeference file in MapInfo format.

3.3.2.2 *Measuring points on raster map*

Ground control points coordinates could be obtained from scanned and georeferenced raster map. More details about raster map georeference see in the chapter 3.3.2.1 Raster map georeference.

The button (**open map**) opens georeferenced raster map (file in TIFF, JPEG, BMP, IMG, PNG, NTF, GIF, PIX, JP2, DEM format), and also georeference data file (in MapInfo TAB

format with the same name as map file). Then this map is used for additional points recognizing and adding their coordinates to the list of measured points (in georeference file), located under image in the **Measuring ground control points** window. To add new point with its coordinates place marker on this point in raster map window and push the button (**map measure**), then dialogue with point's features appears:

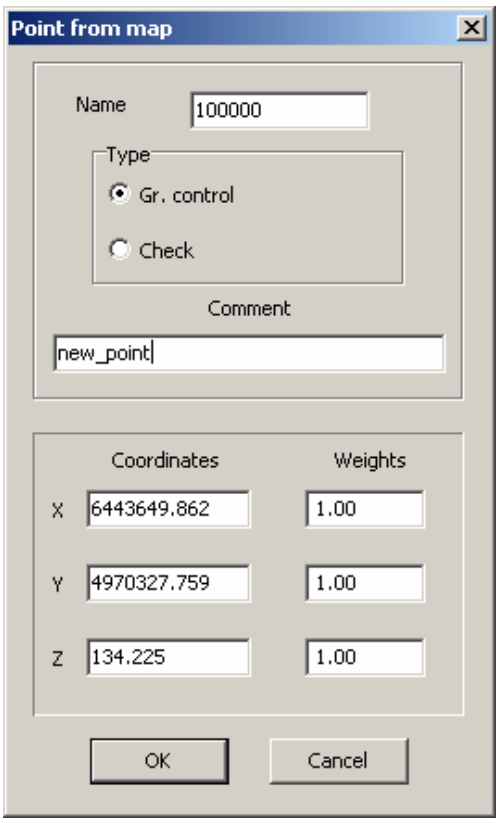


Fig.21 Window for adding points from map

The window **Point from map** opens, where you can choose point's type (ground control or check), edit its name, and add a comment. Then input (or edit) Z-coordinate and edit coordinates weights if necessary. After pushing **OK** point's coordinates appear at the end of GCP list in the **Measuring GC points** window.

If it is necessary to find the point measured on image in the window with opened map using its coordinates, select the point in the lower list of the **Measuring GC points** window and push the button (**find on the map**). Marker in the **Map** window will be placed to the position of the point selected.

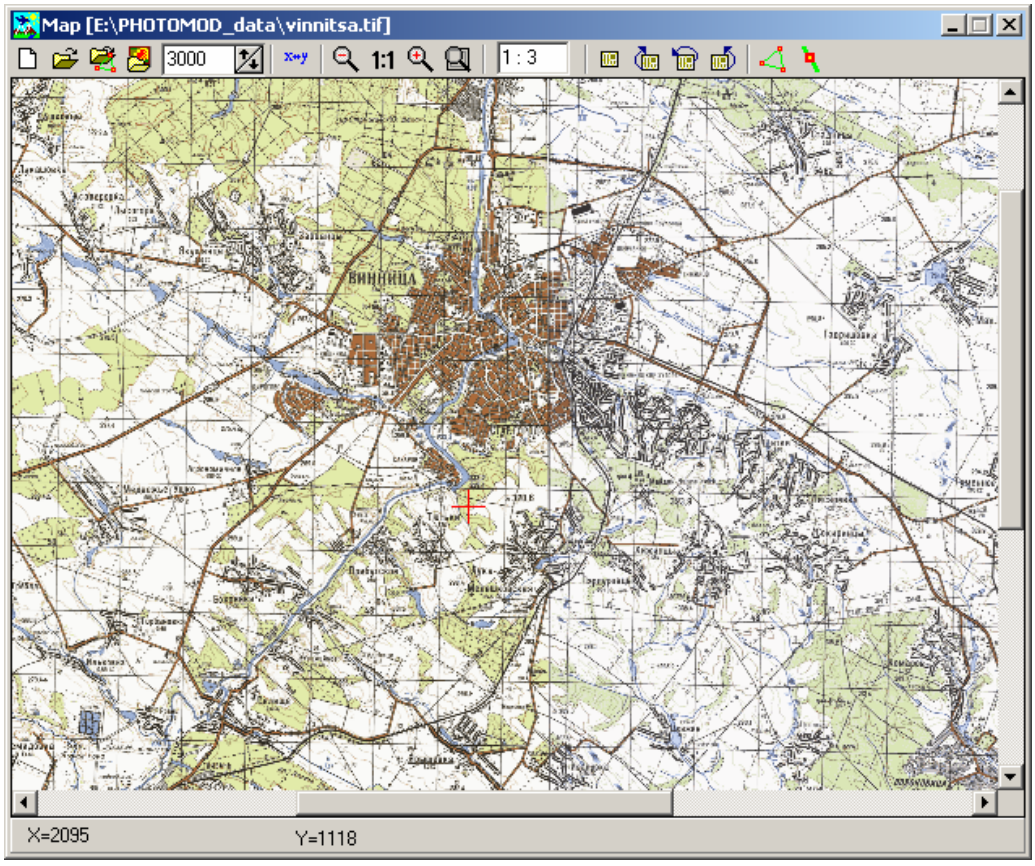


Fig.22 Raster map window

Upper button bar contains the following options:

- close map – closes vector and raster maps, opened in this window before

- load raster map (duplicated by **Ctrl-O** hot keys) – opens dialogue for file selection in raster formats (TIFF, JPEG, BMP, IMG, PNG, NTF, GIF, PIX, JP2, DEM)

- load vector map – opens a dialogue for selection of vector format file (PHR (PHOTOMOD resource format), DGN, DXF or Shape), see the chapter 3.3.2.3 Measuring points on vector map

- load DEM – opens a dialogue for selection of PHOTOMOD resource, containing DEM, see the chapter 3.3.2.3 Measuring points on vector map, used for measuring Z coordinate of collected GCP

- used for control of object's scale in the window

- show vectors – hides/shows vector objects over the raster map, if vector file is opened

- show vertices – shows/hides vertices of vector objects, if file with vector objects is opened

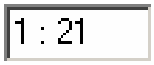
- swap X,Y – allows to swap X and Y coordinates

- zoom out (duplicated by the */* key)

- original size 1:1 (duplicated by **Alt-1** hot keys)

- zoom in (duplicated by * hot key)

- fit to window (duplicated by **Alt-Enter** hot keys)

 - shows zoom scale in raster map window

Pan mode is on when **Alt** key is pressed down.

For more convenient work you can rotate the map in the following ways: - without rotation, - turn at 90 degrees, - turn at 180 degrees and - turn at 270 degrees. At that raster file is not changed and the rotation is executed “on the fly“.

3.3.2.3 *Measuring points on vector map*

If there are vector objects referenced to coordinate system, you may open them in **Map** window and use for measuring of GCP coordinates. Open **Map** window by pushing the button (**open map**). Then load vector objects by pushing the button (**load vector map**). In the dialogue opened select file or several files of vector format: PHR (PHOTOMOD resource), DGN, DXF or Shape.

If you need to swap X and Y coordinates of vector objects vertices during their loading from PHR and Shape formats, i.e. to change left handed coordinate system to the right handed one (or vice versa), mark the option **Swap X,Y** in opened dialogue.

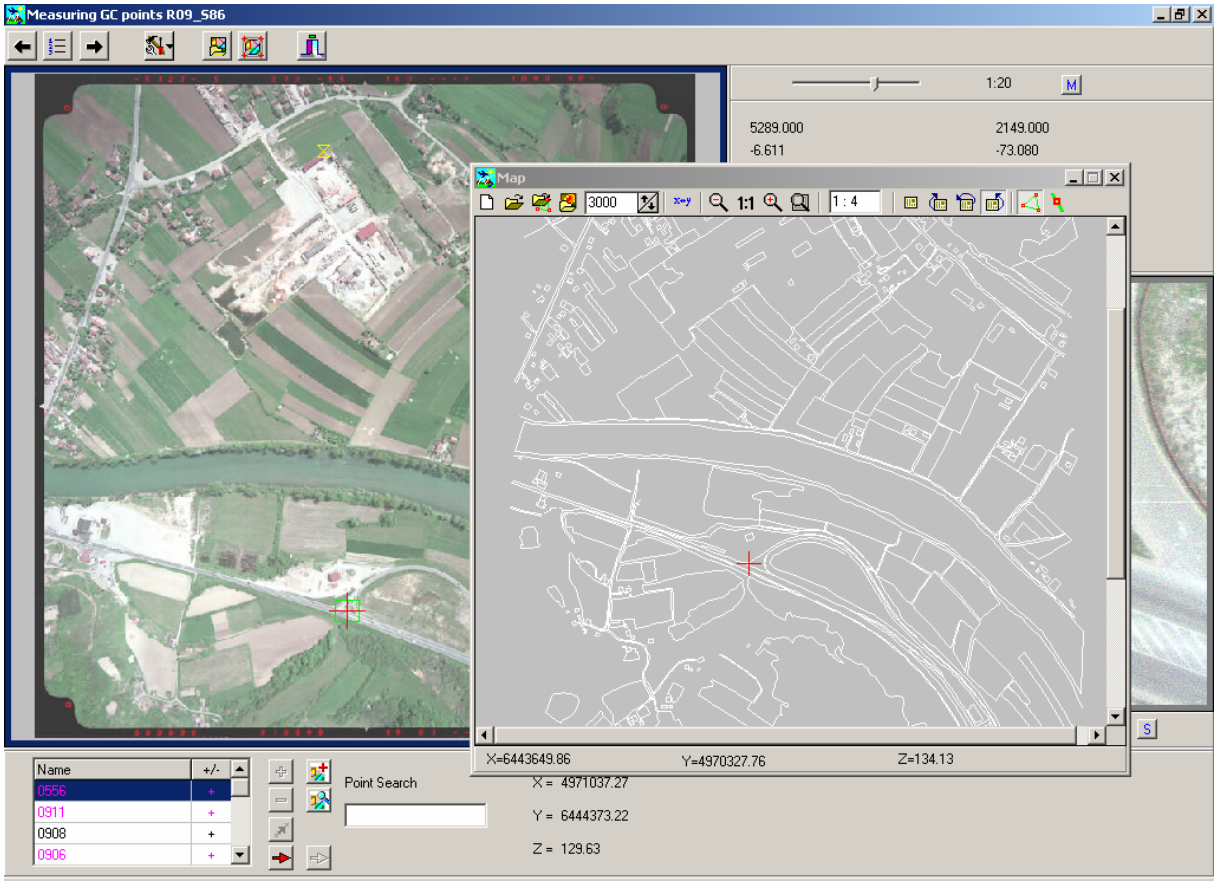


Fig.23 GCP collecting on vector map

After that vector objects set is opened in **Map** window. You can use it to measure X,Y GCP coordinates right in the same way as for raster map, see the chapter 3.3.2.2 Measuring points on raster map.

You can use existing DEM to collect Z coordinates of GCP. Load it by pushing the button **load DEM**. When the DEM is loaded, Z coordinate of cursor location is shown in the lower row of the window near X and Y coordinates.

Place the cursor to the measured point in the **Map** window and push the button (**map measure**) in **Measuring GC points** window. The window **Point from map** opens, where you can choose point's type (ground control or check), edit its name, and add a comment. Then input (or edit) Z-coordinate and edit coordinates weights if necessary.

After pushing **OK** point's coordinates appear at the end of GCP list in the **Measuring GC points** window.

3.4 *Adding of tie points*

To perform phototriangulation you need to measure a set of ***tie*** points on overlapping images (in addition to control points). Tie points are used to create models from pairs of adjacent images and to create from these models the model of the whole strip or block in the block adjustment procedure.
If the block adjustment purpose is only calculating the image exterior orientation parameters it is not necessary to select tie points on well distinctive details of a surface, because tie points on overlapping images are measured either automatically using the correlation algorithm or stereoscopically by an operator.
If one of the goals of making phototriangulation is to measure ground coordinates of some points on images, which afterwards can be used as ground control points in further photogrammetric processing, then tie points should be chosen on well distinctive terrain details. Such points are referred to as ***targeted*** points below. The point type may be changed in the **Point properties** window (see the chapter 3.4.2 Tie points measurements).

Measuring points means their stereoscopic measuring on both stereo pair images.

Stereoscopic measuring can be fulfilled in three following ways:
- by manual positioning of the marker on each of two images;
- by manual positioning of the marker on one image and transferring the marked point to another image with correlation;
- by manual positioning of the marker in stereo mode.

Tie points can be measured in full automatic mode on both stereo pair images using correlation procedure.
The following tie points position considered as an optimum: tie points are grouped in the special standard zones in the triple images overlap, at least 2-3 points in each group (Fig.24).

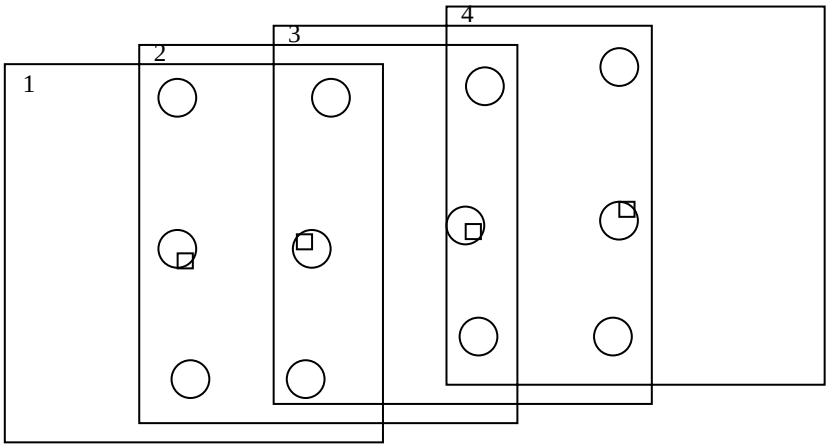


image principal point
tie points location zones

Fig.24

Interstrip tie points should be located in the side lap areas symmetrically relatively to its midline approximately as shown on Fig.25.

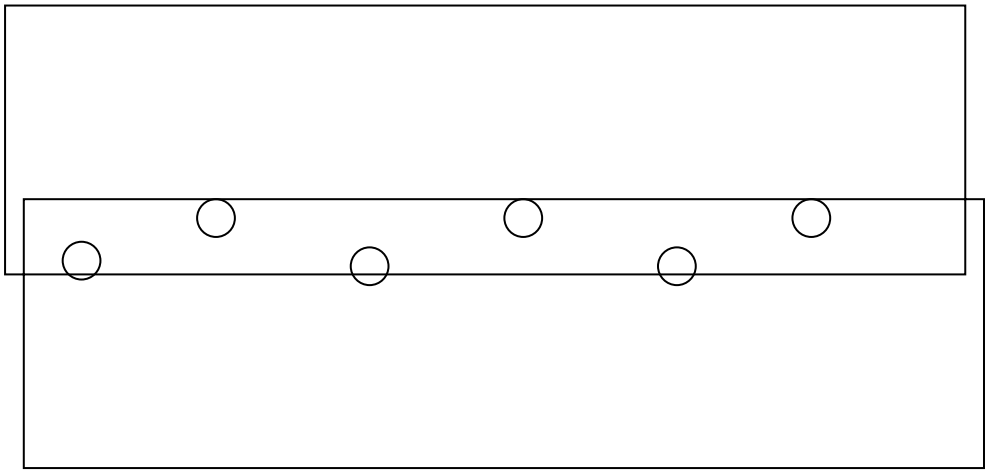


Fig.25

Note. After entering a tie point in the inter-strip overlap area the results of the relative orientation procedure for the images containing this point are rejected, so you should enter such points before making orientation of stereo pairs in strips

Note. Inter-strip tie points must be transferred to at least one adjacent image in each strip. Otherwise they will not be taken into account in the block adjustment by independent models method

3.4.1 Interstrip ties

To measure tie points on the overlapping images of adjacent strips, click the **Strip Ties** tab of the **PHOTOMOD AT** window. The **Strip ties** page (Fig.26) opens.

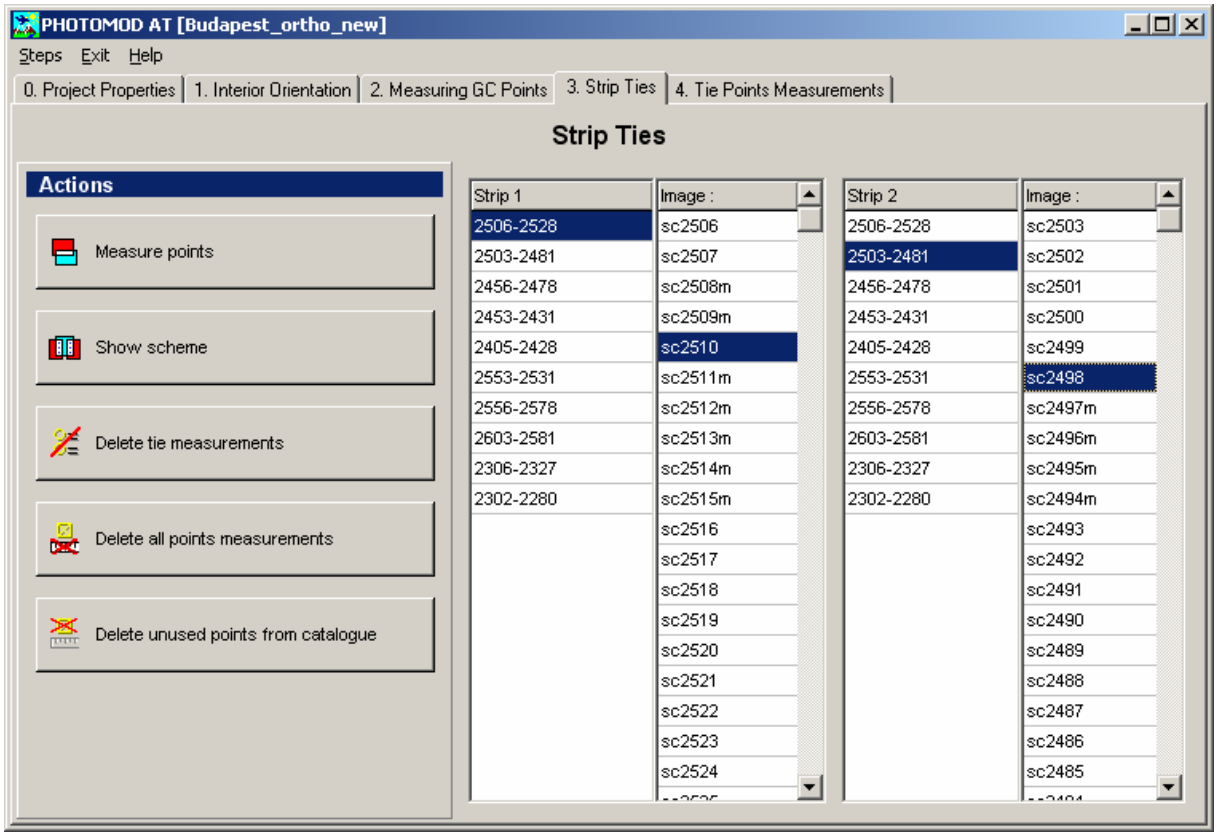


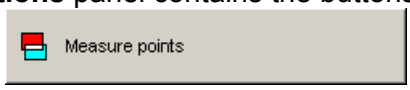
Fig.26 **Strip ties** tab

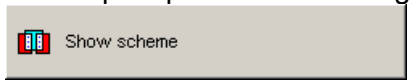
This page contains two lists of images: **Strip 1** and **Strip 2**. Strip names are shown above the top left corner of each list.

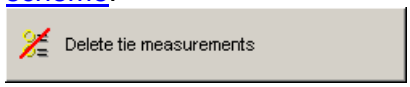
Note. To view already measured tie points on the graphical scheme of the block, click the ***button, see the chapter 3.4.4 Working with block scheme***

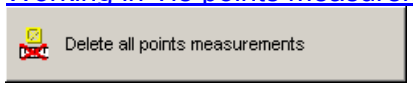
To select strip or image click it by the mouse.

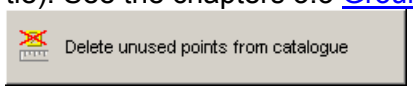
Actions panel contains the buttons allowing to perform the following:

- 

- **Measure points**, opens a window (Fig.27), to measure interstrip tie points on two images, see the description below
- 

- **Show scheme** – opens a window showing the block layout and the position of the measured points, see the chapter 3.4.4 Working with block scheme.
- 

Delete tie measurements (see the chapter 3.4.2.2 Working in Tie points measurements window)
- 

Delete all points measurements (ground control and tie). See the chapters 3.3 Ground control points input and 3.4 Adding of tie points
- 

Delete unused points from catalogue – used to delete from GCP catalogue points, imported from large area projects and located out of current block and thus excluded from further measurements.

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To measure inter-strip tie points, select two images of adjacent strips, by selecting the appropriate strips first and then the images. Then click the button (**Measure points**).

Note. The button is inactive, if the same strip is selected twice

The window opened (Fig.27) contains two main raster windows and two lens windows arranged vertically and displaying of two selected images.

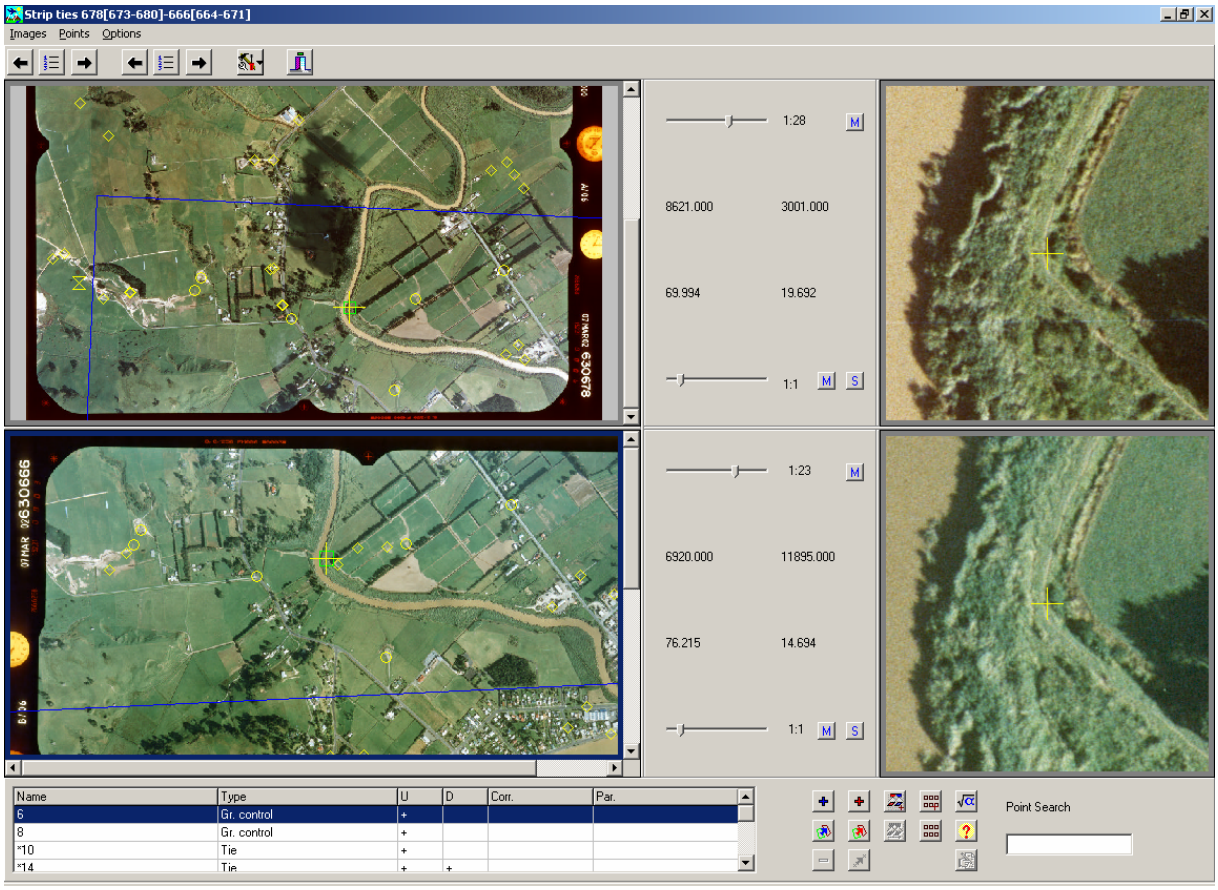


Fig.27 Measurement of points on the adjacent strips images

The set of buttons located in the upper part of the window contains:

- two groups of buttons (, ,) for selection the upper and the lower images;
- settings button (see settings description in the chapter 3.2.3 Manual measuring of fiducial marks),
- button for exiting from the measurements procedure.

Changing correlator parameters procedure is available by selecting the **Correlator** item from the **Options** menu (see the chapter 3.4.2.7 Correlator parameters).
Working with GCPs and tie points in the inter-strip overlapping area is quite similar to the procedures described in the chapter 3.4.2.5 Measuring of tie points on the stereopair for two overlapping images of the same strip, except the automatic procedure of adding and transferring points. You can add or transfer tie points in stereomode using the following icons:

Add in stereocomparator – for new tie point measuring on images pair

Transfer in stereocomparator – for current tie point transferring to adjacent image

See the chapter 3.4.2.6.2 Stereocomparator mode.

You can also measure tie points between strips automatically (using correlator), by selecting menu command **Points | Add | Automatically**. In the window opened you should indicate the number of interstrip points and correlation threshold, which is used for points search (95% by default). Advanced users can also change searching and correlation parameters, setup by default in the window opened by pushing the **Parameters** button. See parameters description in the chapter 3.4.2.7 Correlator parameters.

Note. Unlike tie points measurements between images described in the chapter 3.4.2, while measuring inter-strip ties you do not calculate relative orientation parameters and vertical parallax errors, and in the list of the measured points the upper and the lower images are referred to as U and D respectively

You can also view, add or/and edit measured point on all images where it is located, pushing accordingly the button or in lower button bar. After that you will get the **Point Editor** window opened, which contains the images where this point has been measured (see the chapter 3.4.5 Point editor window).

After adding of tie point to the list you may calculate vertical parallax on it by pushing the button (**calculate vertical parallax**), after that the parallax value is shown in the appropriate cell of the list.

To search the point in the list enter its name (or number) in the **Point search** field, and after that the marker moves into this point both in the image and lens windows, and its record is highlighted in the points list.

3.4.2 Tie points measurements

3.4.2.1 *Tie points measurements tab*

To start the procedure of points (tie, targeted and ground control) measurements click the **Tie points measurements** tab of the **PHOTOMOD AT** window (Fig.28). The tab contains the list of the block strips and the list of the current strip stereo pairs with the "**+**" or "**-**" sign in the column with "**+/-**" heading, indicates whether measurements have been made on the given stereo pair.

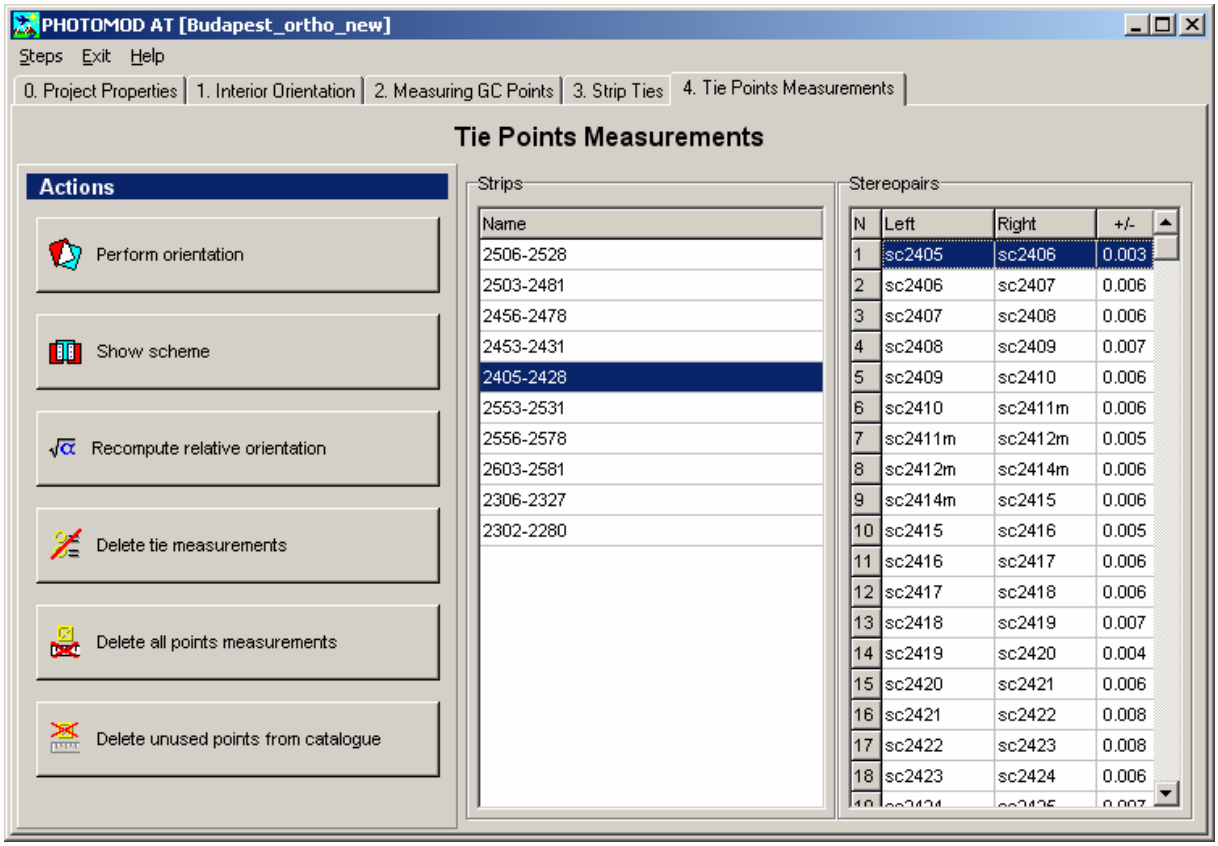
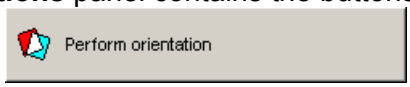
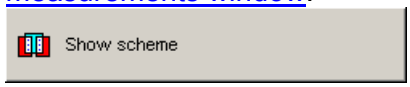


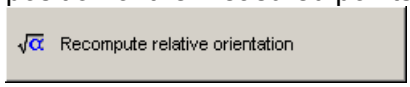
Fig.28 **Tie points measurements** tab

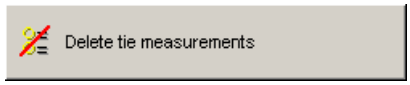
Although the program allows making measurements on stereo pairs in an arbitrary order, it is recommended to follow the natural order of stereo pairs in strips.

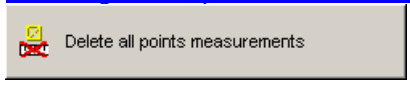
Actions panel contains the buttons allowing to perform the following:

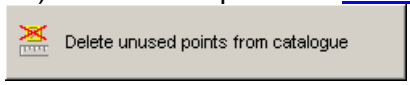
- 

- **Perform orientation** – opens a window used to make measurements on the current stereopair, see the chapter 3.4.2.2 Working in Tie points measurements window.
- 

- **Show scheme** – to show the strip layout and the position of the measured points, see the chapter 3.4.4 Working with block scheme.
- 

- **Recompute relative orientation** – used to recalculate relative orientation for all stereo pairs that got any changes (like tie points deletion, adding inter-strip points, etc). Be careful since there is no control of the relative orientation in this case
- 

Delete tie measurements (see the chapter 3.4.2.2 Working in Tie points measurements window)
- 

Delete all points measurements (ground control and tie). See the chapters 3.3 Ground control points input and 3.4 Adding of tie points
- 

Delete unused points from catalogue – used to delete from GCP catalogue points, imported from large area projects and located out of current block and thus excluded from further measurements.

3.4.2.2 *Tie points measurements window*

To measure points in the **Tie points measurements** window, select a strip from the list of strips, then a stereo pair from the list of the current strip stereo pairs and push the icon on the **Actions** panel of the **Measuring tie points** tab. **Measuring tie points** window appears (Fig.29), which contains two raster images of the stereo pair and two lenses for the left and right images respectively.

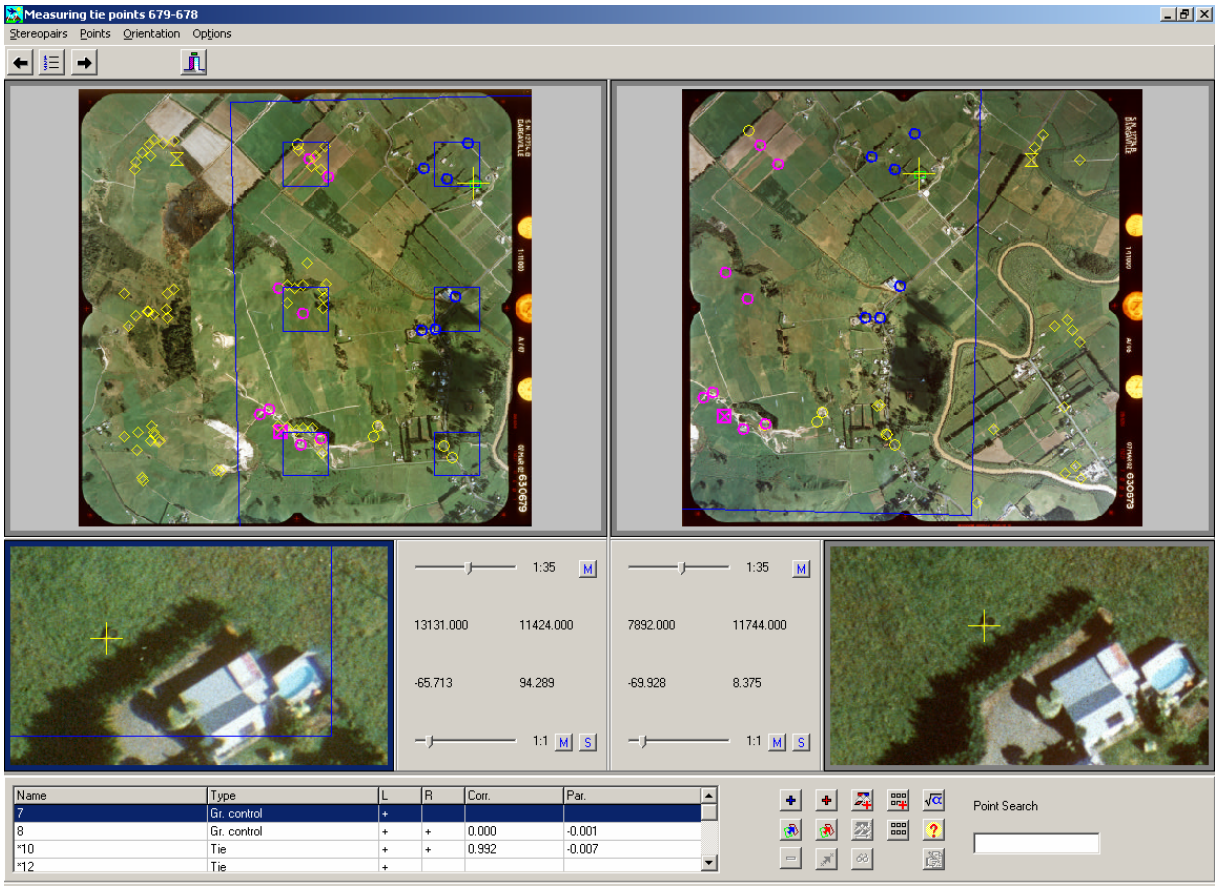


Fig.29 Relative orientation

Working with raster images is described in the chapter 3.5 Working with raster images.

This window contains also the following tools:

- splitter line between images lenses and point's list. You can drag it up to extend point's list.
- In point's list: click the column header along with pressed **Ctrl** key and the values of the column cells will be sorted in reverse order.
- You can select and delete group of points on the image, using polygon in the following way: by mouse clicks along with pressed **Shift** key, after that the measurements of these points will be deleted.

There is a group of icons at the upper part of the window. These icons are used for the following operations:

- - **Prev. stereo pair** – to move to the previous stereo pair,
- - **Select stereo pair** – to select any of the strip stereo pairs,
- - **Next stereo pair** – to move to the next stereo pair,

- - **Exit** – to exit point's measurements procedure and to close the **Measuring tie points** window.

Use menu item **Options** to adjust image radiometry, marker parameters and point fixation type (see the chapter 3.4.2.4 Measurements settings and types of tie points fixation).

3.4.2.3 *Measurements settings and types of tie points fixation*

While measuring tie points you define their locations on different block images. The system put restrictions on points moving in accordance with setting of menu item **Options | Point fixation type**. Thus if a point is measured on "1st", "2nd" and "3rd" images and the fixation type is **Fixed** there is no way to move point on the "middle" – "2nd" image without its deleting on "first" or "third" images (see the chapter 3.4.2.5 Measuring of tie points on stereopair). To manage point degree of freedom use following options of the menu item **Point fixation type**:

- **Fixed** (default mode) – when measuring a point on the first of stereo pairs where it is imaged you can move this point on any of two images. Afterwards, when measuring this point on other stereo pairs the point position will be fixed on images belonged to stereo pairs where this point has been already measured.
- **Semi-fixed** – in this case moving a point on one image (or both images of the current pair) causes corresponding moving at the same distance (pixels) and direction on all images with this point. Be careful when working in this mode, since a point changes its location on images that currently are not displayed.
- **None** – points are moved independently and without restrictions on all images.

Besides, menu item **Options** allows to setup the following measurement parameters:

Marker – opens a window for color, shape and size of marker adjustment, see the chapter 3.5.3 Marker parameters.

Correlator – used for adjusting of correlation algorithm, see the chapter 3.4.2.7 Correlator parameters.

Zone size – allows to adjust the size of areas on stereopair, where points are measured automatically, see the chapter 3.4.2.5.4 Automatic adding of new points.

Brightness/contrast – allows to adjust brightness, contrast and gamma correction of left or right image of stereopair. See the chapter 3.5.2 Adjusting brightness and contrast.

Automatic calculations – if the option is on, relative orientation is recalculated automatically each time after point is measured on image.

Display styles – opens a window to change color or visualization style (normal or bold) of all types of points overlap boundaries and zones. Double click on color cell opens standard color palette of OS Windows, to select the color.

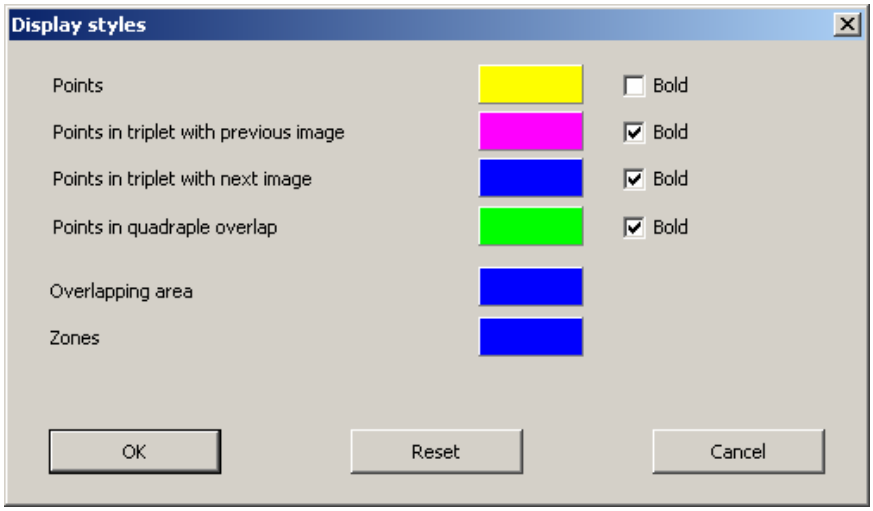


Fig.30 Colors and styles settings for objects in **Measurements** window

Show – in sub-menu opened you may turn on/off points, overlap areas, zones and points in triplets.

See also the chapter 3.4.2.5 Measuring of tie points on the stereopair and 3.4.2.6 Measuring of points in stereo mode.

3.4.2.4 *Measuring of tie points on stereopair*

3.4.2.4.1 Tie points measuring tools

Operations of point's measurements are executed using either pull-down menu at the top of the window or group of icons located in the lower left part of the window. These icons are used for the following operations:

- - **Add with correlation** – to add the point using correlation,
- - **Add without correlation** – to add the point without correlation,
- - **Transfer with correlation** – to transfer the point using correlation,
- - **Transfer without correlation** – to transfer the point without correlation,
- - **Move to marker position**
- - **Delete** – to delete the point,
- - **Calculate relative orientation** – to calculate the relative orientation for the given stereo pair, see the chapter 3.4.4.1 Accuracy control using vertical parallax residual
- - **Status** – to show the status information,
- - **Stereo positioning** – to open **Stereo lens** window, to measure the point in stereo mode (see the chapter 3.4.2.6.1 Stereomode with moving marker)
- - **Show/Edit on all images** – to open **Point Editor** window that shows selected point on different images of the block, where you can re-measure the point on all images where it exists (see also the chapter 3.4.5 Point editor window)
- - **Add/Edit on all images** – to open **Point Editor** window that allows to add and measure a new point on different images of the block on all images where it exists (see also the chapter 3.4.5 Point editor window)

- - **Add in "Stereocomparator"** – to open **Stereocomparator** window, where you can add a new point in fixed marker mode (see the chapter 3.4.2.6.2 Stereocomparator mode (fixed marker))
- - **Transfer in "Stereocomparator"** – to open **Stereocomparator** window, where you can transfer an existing point on other image in fixed marker mode (see the chapter 3.4.2.6.2 Stereocomparator mode (fixed marker))
- - **Edit type** – to edit the current point properties: **Name**, **Type** (**Tie**, **Control** or **Targeted**) and **Comment**.

To search the point in the list, enter its name (or number) in **Point search** field, after that the marker moves into this point both in the image and lens windows, and its record is highlighted in the points list.

3.4.2.4.2 Transferring of existing points

If some tie or ground control points have been measured on the previous steps on one of the stereo pair images, it is recommended to start measurements with these points. To transfer these points to the other image of the stereo pair, use either the icons (**Transfer with correlation**) or (**Transfer without correlation**). You can also use the **Transfer | With correlator** or **Transfer | Without correlator** menu commands from the **Points** pull-down menu with the same effect.

To transfer a point with correlation, select it by clicking the corresponding line in the list of points or by double clicking the point in the raster image. The marker is positioned precisely at the image on which the point has been measured. On the other image the marker is positioned approximately in the neighbor area of the measured point (for the first transferred point the approximation may be not very precise). After selecting a point, click the icon or use the **Points | Transfer | With correlator** menu command to transfer the selected point. The position of the point at another image will be adjusted using correlation. The displayed correlation value represents the reliability of the matching made by the correlation procedure.

Note. Measuring GCP in stereo mode is possible after the relative orientation has been made for the given stereo pair

Note. You may see the message "Bad point" when transferring a point with correlation, which means that the program failed to find matching point with sufficient correlation value (greater than 0.4) or the point is in a poor texture area

To transfer the selected point without correlation (manually), place the marker at another image as precisely as possible and click the icon or use the **Points | Transfer | With correlator** menu command.

When one point has been already transferred (or measured - see below), the boundaries of the overlap area are shown on both images. When 5 points have been transferred (or measured), the rest of points can be transferred automatically using the **Points | Transfer | Automatically...** menu command.

The icon (**Move to marker position**) is used for moving point to marker position on two current images. You can set point position on one image and press **Shift** + **spacebar** to define its position on the second image automatically by the correlator. Moving point to

marker position function is basically used for **Semi-fixed** and **None** points fixation modes (see the chapter 3.4.2.4 Measurements settings and types of tie points fixation).

3.4.2.4.3 Adding new points

Measuring of new tie and targeted points is performed in one of three ways using the **Points | Add** pull-down menu commands, duplicated by the following icons at the lower left part of the window:

- - **Add with correlation** icon or the **Points | Add | With correlator** command or the **Space** key,
- - **Add without correlation** icon or the **Points | Add | Without correlator** command or **Ctrl-A** hot keys,
- **Points | Add | Automatically** menu command, see the chapter 3.4.2.5.4 Automatic adding of new points.

Measuring points using the first two ways is applicable if you want to place those points on well distinctive features of an image. To measure a point using correlation, pose the marker in the left image precisely on the point you want to measure (see the chapter 3.5 Working with raster images for details about point selection in raster images) and click the icon or select the **Points | Add | With correlator** command from the pull-down menu. After successful measurement, the point appears in the list of measured points. You can change the point properties by clicking the icon or selecting the **Points | Properties** menu item.

When measuring points without correlation you need to position markers on both images exactly on the same image (terrain) feature and click the icon or select the command **Points | Add | Without correlator** from the pull-down menu.

Once the point has been measured, its name (ordinal number by default) appears in the list of points in the lower left corner of the window.
This list contains the following information about points:

- point number;
- point type (“Tie“ or “Gr. control“);
- symbol “+“ or “-“ in the “L“ and “R“ column that indicates whether the point has been measured on the left or the right image correspondingly;
- correlation value (if the point has been measured using correlation);
- residual vertical parallax (after relative orientation has been calculated).

Name	Type	L	R	Corr.	Par.
*32	Tie	+	+	0.961	-0.005
*33	Tie	+	+	0.968	-0.004
*35	Tie	+	+	0.961	0.004
0908	Gr. control		+		

The list can be sorted according to values in any of its columns by clicking the column header. After any change in the list (correlation, adding a point) the sorting must be repeated, since there is no automatic re-sorting.

3.4.2.4.4 Automatic adding of new points

If there is no need to select points on well distinctive details, you can measure tie points using automatic measurement procedure. For this purpose, select the command **Points | Add | Automatically** (it becomes active when at least 5 points have been measured on the

stereo pair) to open the window of points search parameters. In this case the program measures specified number of points (in the **Points quantity** field in parameters window) located either in the special zones (the size and position of which you can adjust) or distributed in the entire overlap area. Searching process is executed using correlation algorithm, and you can adjust it by changing the option **Correlation threshold** (the minimal acceptable value of correlation coefficient for tie point to be included to processing).

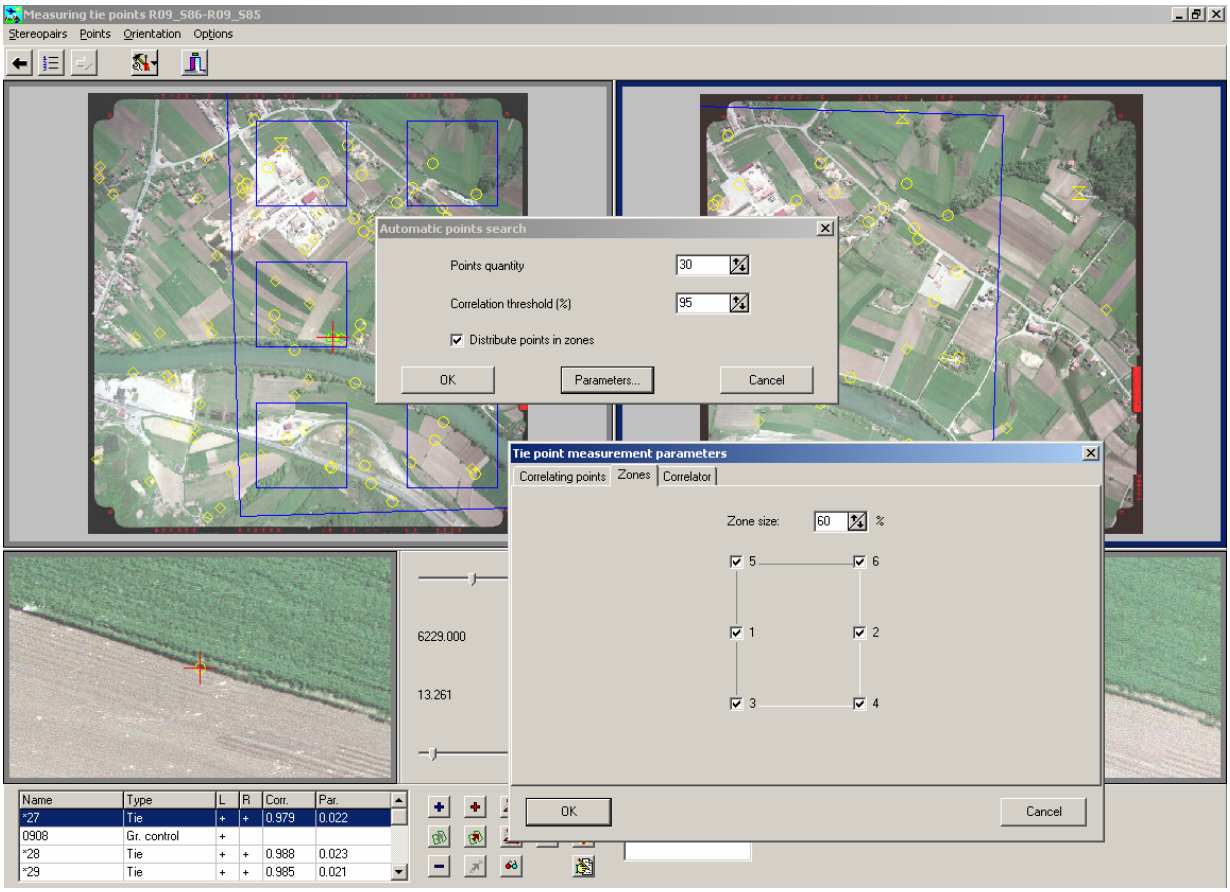


Fig.31 Adjusting of automatic points measurement

If the option **Distribute points in zones** is off, points are measured on the entire stereopair area uniformly.
If the option **Distribute points in zones** is on, points are measured in zones, located in images overlap area. Push the **Parameters** button and adjust parameters of automatic points search in the opened window, which includes three tabs.

To adjust zones of points search use the **Zones** tab. Select zones size in the appropriate field (you can also input the size in the window opened by the menu command **Options | Zone size**).

The **Zones** tab also contains a scheme of zones (from 1 to 6), where you can select any number of zones checking them on the scheme.

In the same window on the **Correlating points** tab (see Fig.32) you can adjust the following parameters, used also for automatic search and measurement of tie points in **PHOTOMOD AAT** module (see the appropriate User Manual):

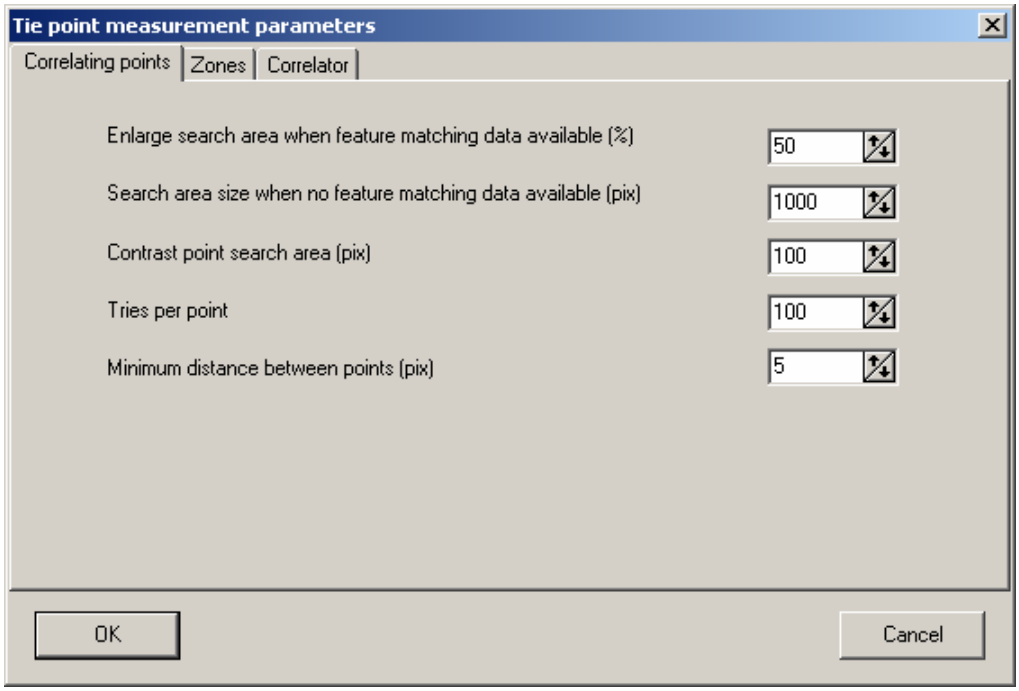


Fig.32 Parameters of automatic points search

- **Enlarge search area when feature matching data available (%)** – data of automatic features matching is used for preliminary evaluation of search area for correlation algorithm. It is necessary to enlarge this area on specified value (50 – by default) for reliable processing.
- **Search area size when no feature matching data available (pix)** – size of searching area for correlator when there is no (or failed) features matching between images of stereopair and there is no evaluation of the searching area. You should enlarge this value (up to 20-30% of the image size), if there are some difficulties with automatic ties measuring.

Note. Refer to the PHOTOMOD AAT User Manual for the description of figures matching procedure

- **Contrast point search area (pix)** – default value is 100. The parameter is used for tie points search in areas of maximal contrasts (images with clear object's features). In some cases it is recommended to measure points in areas with low contrast (for example, when maximal contrast corresponds to forested areas, where correlator errors have high probability). The parameter value may be reduced there up to 10 for example.
- **Tries per point** – number of correlation tries for each point (100 – by default).
- **Minimal distance between points (pix)** – minimal distance in pixels of the initial image between points measured on the image (5 – by default). You may increase the parameter if it is difficult to adjust the block in **PHOTOMOD Solver** module (please note that this limit is applied only to newly measured points, and already measured points will be not filtered).

The **Correlator** tab allows to adjust the following parameters of correlator:

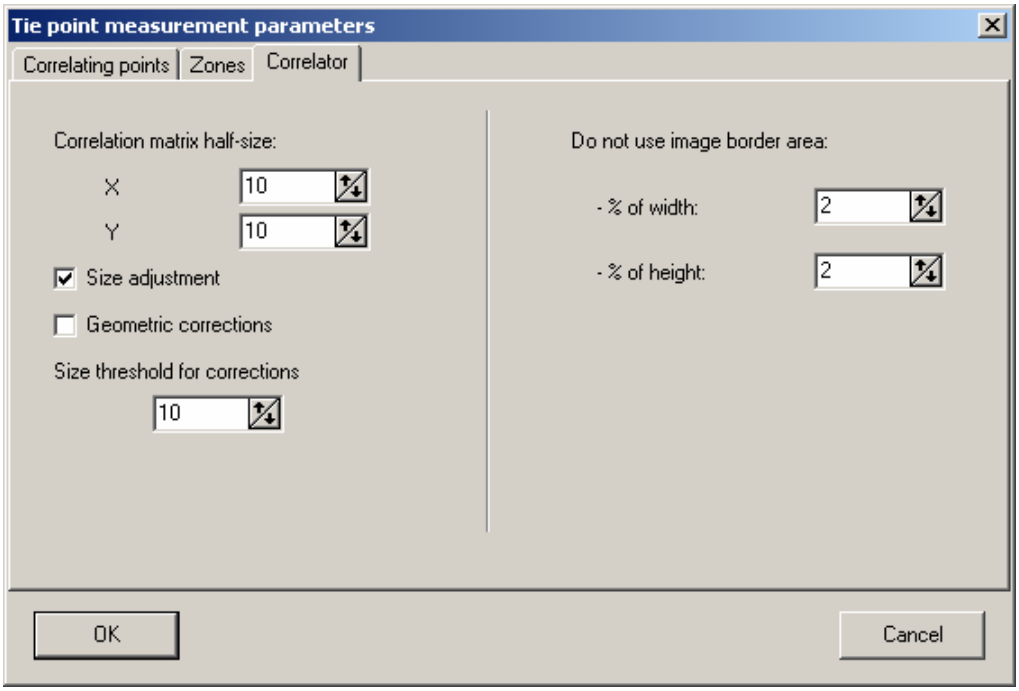


Fig.33 Parameters of correlator for automatic points searching

- **Correlation matrix half-size** on X and Y axes – setup matrix size (in pixels) for search of the corresponding points in pixels (**10x10** by default). In most cases it is not recommended to increase this size due to it causes slowing down the processing;
- **Size adjustment** of correlation matrix – used in case of low terrain contrast on the images.
- **Geometric corrections** – geometric correction mode is used only if correlation matrix size (**Correlation matrix half-size** option) is more than threshold value (**Size threshold for corrections** option). It is also recommended to use geometric correction mode when measuring points on steep slopes.
- **Size threshold for corrections** – allows to adjust threshold value for correction, and when it is exceeded the **geometric correction** is applied. Default value is **10**.
- **Do not use image border area** – service information area with specified width near the image edge should not be used for correlator work. Service area width (2% of image width and height by default) should not be less than on the image, otherwise a big amount of wrong points would be measured in image service areas.

See the detailed description of correlator parameters in the chapter 3.4.2.7 Correlator parameters.

When all parameters are set, start the search procedure by pushing the **OK** button.

3.4.2.4.5 Changing point type

To change the point type, to select it in the list and click the icon or select **Points | Properties** menu option to enter (change) its type (**Type** field), number (**Name** field) and comment in the **Point properties** dialog box.

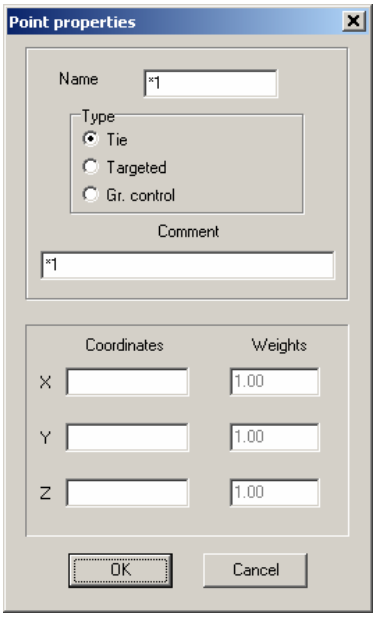


Fig.34 Changing point type

If a point's type is changed to **Gr. control** you should enter point ground coordinates and weight values in appropriate text fields of the **Point properties** dialog.

3.4.2.5 *Measuring of points in stereomode*

Sometimes it is convenient to measure GCPs, check or tie points in the stereo mode (for example, when points are located on outstanding objects such as edges of roofs, columns etc. or on the elements which are visible just on one image in the mono mode – like on the bottom of inner corner of the building).

Once relative orientation is done it becomes possible to use the stereo mode to measure points. Stereo measuring is made in the **Stereo lens** window, opened by clicking the button (working in stereomode with moving stereomarker) or the buttons , (working in stereocomparator mode with moving images and unmoving (fixed) marker). See the description of both stereomodes in the chapters 3.4.2.6.1 Stereomode with moving marker and 3.4.2.6.2 Stereocomparator mode. Note that stereocomparator mode is available for measuring points in overlapping areas between adjacent images of the strip as well as in overlapping areas between strips.

After measuring a point in the stereo mode, recalculate the relative orientation by pushing the button (if the **Automatic calculations** option is set on, the relative orientation is recalculated automatically).

When measuring a point on the first of stereo pairs where it is imaged (point fixation type is **Fixed**) you can move this point on any of two images. Afterwards, when measuring this point on other stereo pairs the point position is fixed on images belonged to stereo pairs, where this point has been already measured in stereo mode. If, for example, the point has been measured on the stereo pair that contains the left image of the current stereo pair, then the point is fixed on this left image while on another image the point can be moved along epipolar line, that means moving along Z coordinate.

To cancel restrictions of points fixation use a mode **Options | Point fixation type | None** (see the chapter 3.4.2.4 Measurements settings and types of tie points fixation).

3.4.2.5.1 Stereo mode with moving marker

To measure a point in the stereo mode select the point in the list and push the button . The **Stereo lens** window opens showing a part of stereo image that contains selected point (see figure below).

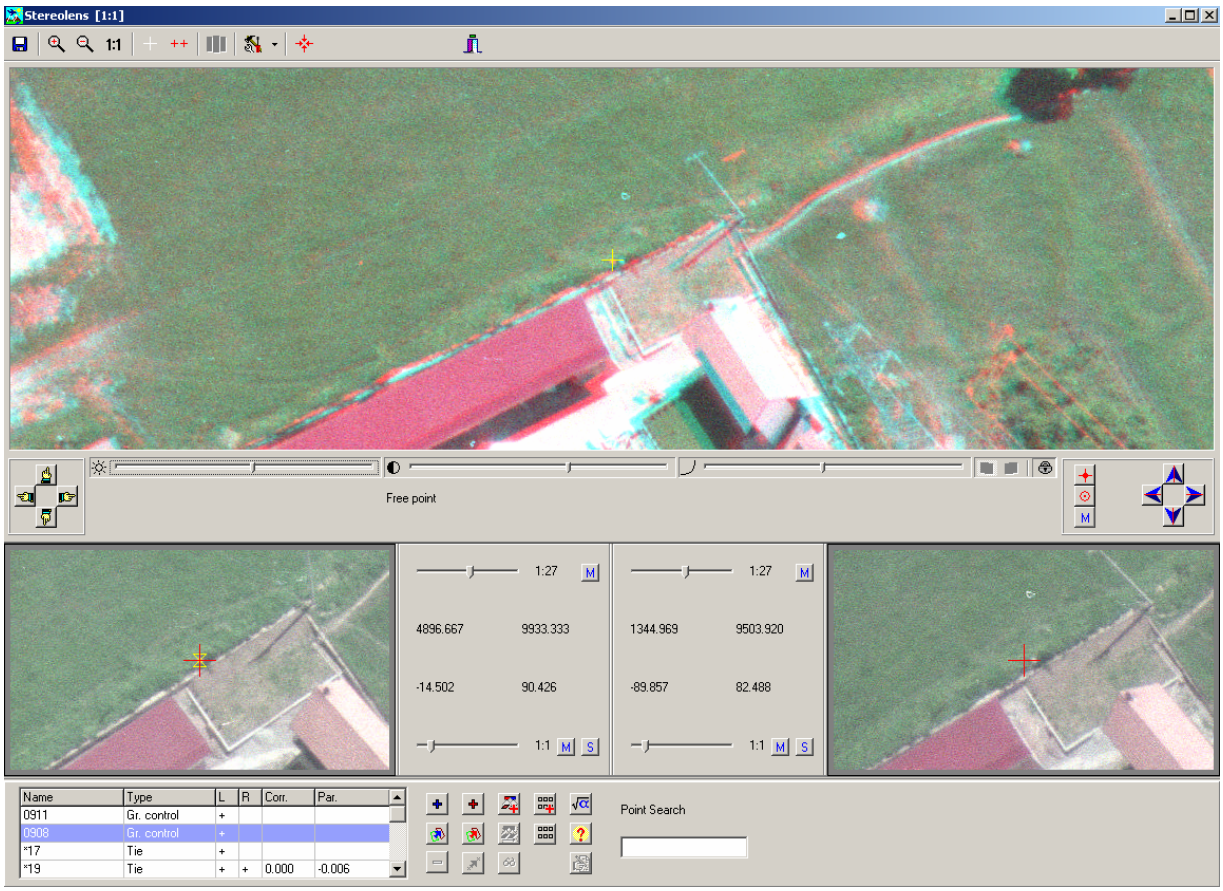


Fig.35 Stereo measurements

By default, the **Stereo lens** window is located over the left and the right image windows, keeping visible the lens of the right and the left images. The stereo marker in the stereo lens moves synchronously with the markers in the left and right lenses.

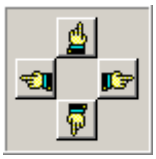
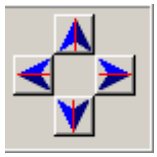
The buttons at the top of the **Stereo lens** window are used for the following operations:

- - **Exit and save measurements**;
- - **Zoom in**;
- - **Zoom out**;
- - **Zoom 1:1** (duplicated by **Alt-1** hot keys);
- - **Adjust depth** (**F2**) – adjusting the stereo image to place stereo marker “in the screen” plane;
- - **Restore depth** (**F3**) – restoring the previous depth level;
- - **Reverse phase** (**F11**) – switching shutter glasses phase;
- - **Parameters** – selecting stereo mode (anaglyph, interlace or page flipping), correlator parameters and stereomarker color;

- - **Correlate** – measuring a point using correlation procedure.
- - **Exit without saving the changes**.

Three buttons at the bottom of the stereo lens are used for following operations:

- - **Marker "down"** – moving the marker "from the operator;
- - **Marker "up"** – moving the marker "to the operator;
- - **Center marker** – moving the marker to the center of the image.

Two groups of 4 buttons each at the left  and the right  lower corners of the stereo lens window are used for moving the stereo lens along the stereo image and moving the stereo marker within the stereo image correspondingly.

If the right group of buttons is not active, it means that the point is fixed at least on one of two stereo pair images. If the point is fixed on one image only, it can be moved on another image along epipolar line (actually along Z) by pressing the <**PageUp**> and <**PageDown**> keys or pushing the , buttons. If the point is fixed on both images it can't be moved at all. See also the chapter 3.4.2.4 Measurements settings and types of tie points fixation.

To measure the point in the stereo mode, position the stereo marker on the point of relief moving it by "arrow" keys along X, Y coordinates and by <**PageUp**> and <**PageDown**> keys or the , buttons along Z coordinate.

To define the color of the stereo marker, click the button and in the pull-down menu select the **Marker parameters** item.

You can also use the correlation procedure for automatic positioning the point in the right image relatively of its position in the left image. If the point is fixed in the right image and it is free in the left image, then the point is positioned in the left image relatively of its position in the right image.

When the point measuring is completed push the button to save the measurement and close the stereo lens window, or the button to exit from stereo lens without saving the changes.

Note. This mode of stereo measurements becomes available after the relative orientation is done at least one time

3.4.2.5.2 Stereocomparator mode (fixed marker)

Unlike the stereomode with moving marker (see the chapter 3.4.2.6.1 Stereomode with moving marker) the stereocomparator mode allows you to move images while the marker is static and located at the middle of the measuring window.

The main advantage of this kind of stereo measurements is that you can position the marker with sub-pixel accuracy (the pixel size depends on the current zoom and the marker moving step is defined by the sensitivity slider located at the bottom of the window). Another advantage is that stereocomparator mode is available for adding or transferring tie points

both in the stereopair overlapping area (see the chapter 3.4.2 Tie points measurements) and in the inter-strip overlapping area (see the chapter 3.4.1 Interstrip ties).

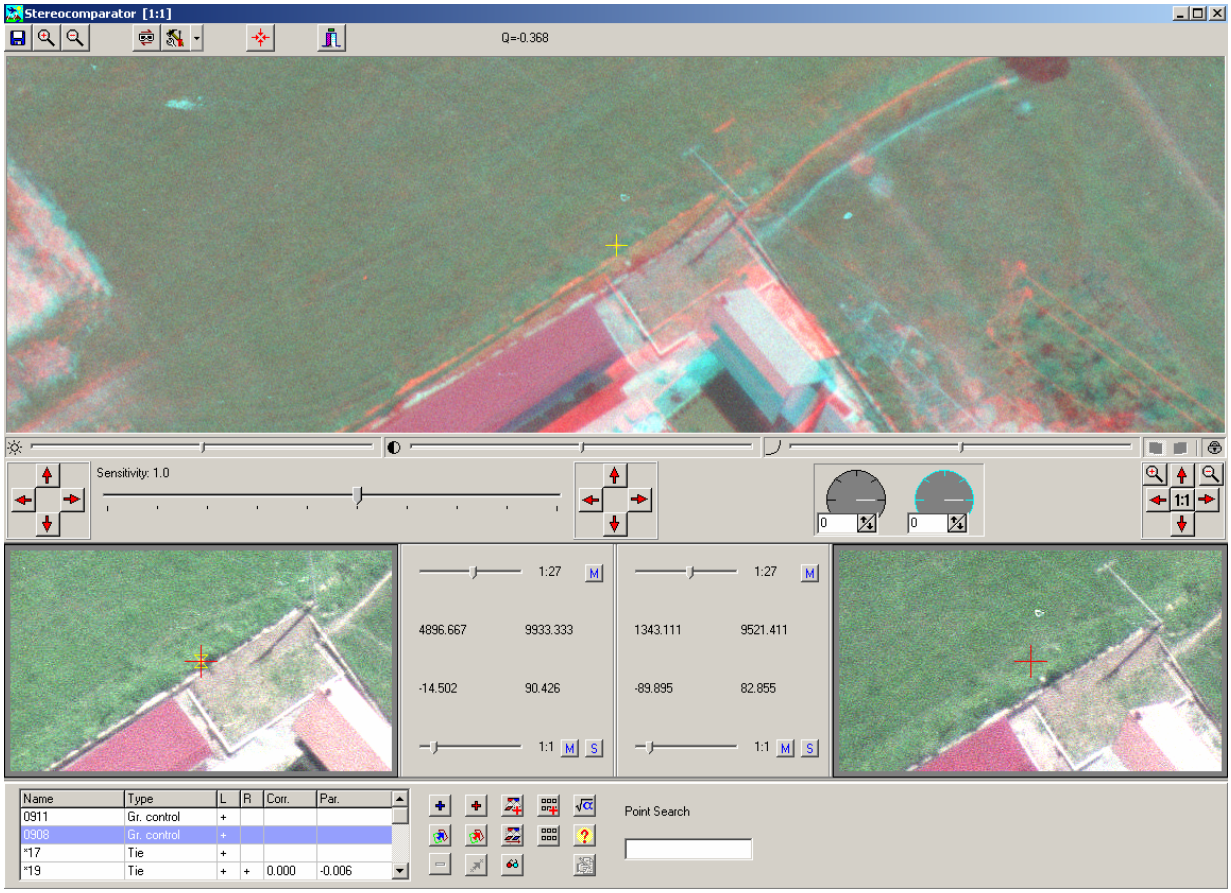
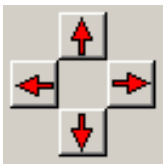


Fig.36 Stereocomparator mode

Use the icon to start stereocomparator mode for transferring selected tie point from one image to another one or the icon for adding a new tie point on both images. As a result stereocomparator window opens (Fig.36). There are 3 groups of arrow buttons at the left, middle and right part of the window bottom:



The left group is used to move the left image in the direction corresponding to the selected arrow (duplicated by **Shift + arrow keys** of the keyboard). Right group (duplicated by **Ctrl + arrow keys**) works in the same way for the right image. The middle group is used to move both images together.

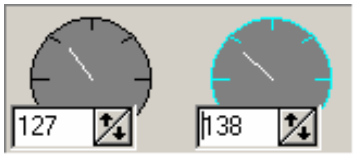
Besides, you can change the scale of the right image using an additional buttons on right arrows group:

- - zoom in right image scale on 5% or on 1% (along with pressed **Shift** key)
- - zoom out right image scale on 5% or on 1% (along with pressed **Shift** key)
- - cancel right image zoom.

The step of moving is set by the **Sensitivity** slider and can change from 0.1 to 20 of the current screen pixel size, which depends on the zoom level. You can also use keys **0**,**1**,**2** ….**9** for quick selecting the current step value. While orienting images you can control the process by viewing the Y-parallax value at the top of window (**Q**). It is displaying in the camera calibration units (usually – mm). Note that this parameter is available just in case of working in the images overlapping area (not for interstrip overlapping area).

If the left or right group of arrow buttons is not active – the tie point is "fixed" (see the chapter 3.4.2.5 Measuring points in the stereomode) on the corresponding image and it cannot be moved. See also the chapter 3.4.2.4 Measurements settings and types of tie points fixation.

For stereomode adjusting you can also use special tool for images rotation, located in lower part of stereocomparator window.



Left "steering-wheel" is intended for both images rotation (by clicking on the wheel field or entering rotation angle value into numeric field). And right wheel – for right image rotation. If you would like to restore the initial image position use double click on the numeric field.

The icons above the **Stereocomparator** window are used for the following operations:

- - **Exit and save measurements**;
- - **Zoom in**;
- - **Zoom out**;
- - **Reverse phase** (**F11**) – switching shutter glasses phase;
- - **Settings** – selecting mode of stereo imaging (anaglyph, interlace or page-flipping), correlation parameters and marker colors;
- - **Correlate** – measuring a point using automatic correlation procedure, at that correlation coefficient value appears in the upper part of the window near Y-parallax value (**Q**).

For more accurate positioning of stereo marker and measuring points in stereo comparator use the following operations:

- To move the image to the specified point by the mouse use: **Alt-Click** – to center both images in the specified point, **Shift-Click** – to center only left image, **Ctrl-Click** – to center only right image.
- To move the image using mouse wheel: mouse wheel rotation moves both images, **Shift-Wheel** – only left image moves, **Ctrl-Wheel** – only right image moves; if the **Alt** key is pressed along with previous combinations, images are moved in Y axis, if it is released – in X axis. Forward mouse wheel rotation is used to move images to the left in X (corresponds to move of marker down in Z along with pressed **Ctrl** key), or upward in Y along with pressed **Alt** key.
- Press the **Tab** key to turn on/off the marker. Press the "**~**" key in anaglyph or page-flipping mode to show/hide a rectangle sign above the marker (in Z axis), to define stereo phase.

When the point measuring is completed (the marker is located on the appropriate point of the relief) push the button to save the measurement and close the stereocomparator window. To exit process without saving the results push the icon.

3.4.2.6 *Correlator parameters*

In **PHOTOMOD** system correlation algorithm is used for automatic tie points (identical points on images pair) search and measurement. The algorithm allows to compare the corresponding fragments of images using maximal relative correlation coefficient.

This maximal value is searching on X and Y axes with sub-pixel accuracy. The size of image fragment is defined by the parameter **Correlation matrix half size** and equals (2*X+1)*(2*Y+1) (see Fig.37). For more accurate measurements of pixel coordinates the special algorithm of matrix size reduction is used (turned on by the **Auto resizing** option).

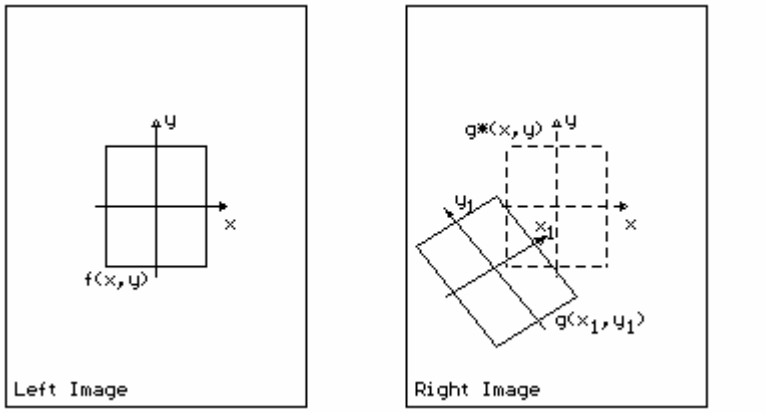


Fig.37 Images correlation

In case if the images are significantly different in geometry due to images relative rotation or mountainous terrain survey, for instance (see Fig.37), more complicated brightness interpolation is applied to "right" images, which uses affine geometric transformation (turn on the **Geometric corrections** option in this case). You should use such a transformation if correlation matrix size is more then the threshold identified (in **Size threshold for corrections** field) after using "auto resizing" procedure on previous step. It should be noticed that if **Geometric corrections** option is on it would result in some slowing down of algorithm work.

The parameters mentioned above are adjusted in the **Correlator parameters** window opened by menu command **Options | Correlator | Parameters**.

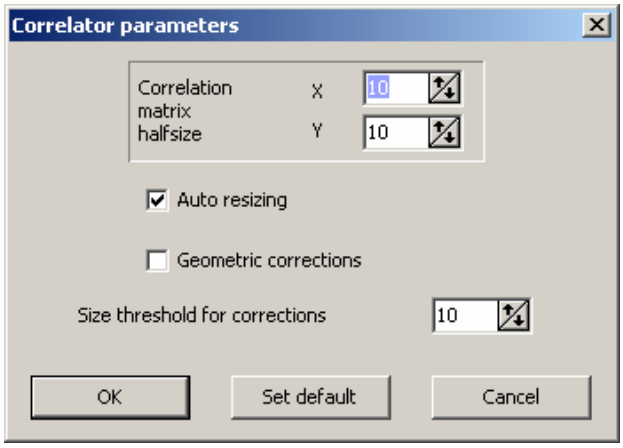


Fig.38 Correlator parameters

In this window you can:

- set the size (in pixels) of correlation matrix in X and Y directions using numeric fields in the **Correlation matrix half size** panel;
- set on/off the **Auto resizing** check box (this option is useful in case of poor contrast images);
- set on/off the **Geometric corrections** option by marking the appropriate check box and specify the **Size threshold for corrections** parameter, that defines the minimal correlation matrix size at which the geometric correction is applied. This option is useful for measuring points located at steep slopes.
- set up the above-listed parameters to default ones by pushing the appropriate button.

3.4.3 Relative orientation and accuracy control

The accuracy control of measured points in **PHOTOMOD AT** module is provided in two ways:

- **on images stereopair** – using the residual vertical parallaxes, measured while images relative orientation, see the chapter 3.4.4.1 Accuracy control using vertical parallax residual;
- **at two adjacent models merging** – calculating the discrepancies in tie points coordinates while tying of two adjacent models, see the chapter 3.4.4.2 Accuracy control by adjacent models tying.

3.4.3.1 *Accuracy control using vertical parallax residual*

To calculate the relative orientation, select the **Orientation | Calculate** menu option or push the button in the **Measuring tie points** window on the appropriate tab of **PHOTOMOD AT** module.

Once the relative orientation procedure has been completed the **Status** window appears.

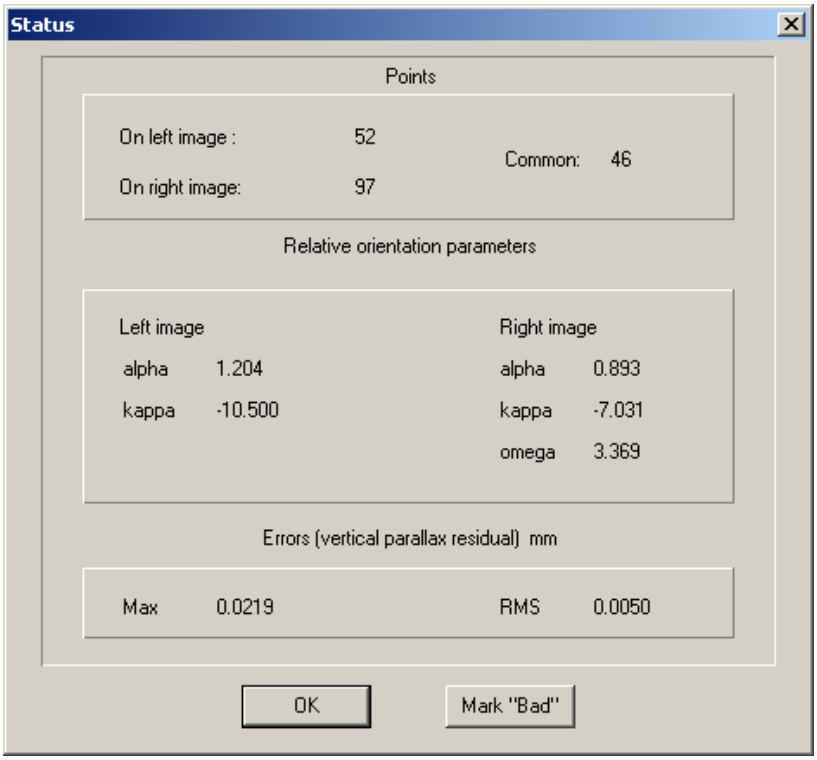


Fig.39 Relative orientation parameters

The **Status** window shows: the number of points on each image of the stereo pair and the number of points common for two images, the relative orientation angles, **RMS** and **Max** error of vertical parallax residuals in mm.

When 5 or more points have been measured, you can use automatic calculations mode, by selecting the **Automatic calculations** item from the **Options** menu. In this mode the relative orientation is recalculated automatically after measuring each new point.

To reject points with large vertical parallax residuals, select the **Rejection** command from the **Orientation** menu (or push the button **Mark "bad"** in the **Status** window), and in the **Point rejection criteria** window set the vertical parallax threshold value. *It is recommended to reject the points with vertical parallax which exceeds image pixel size* (Fig.40). All points with vertical parallaxes exceeding the defined threshold will be marked by red in the list of measured points.

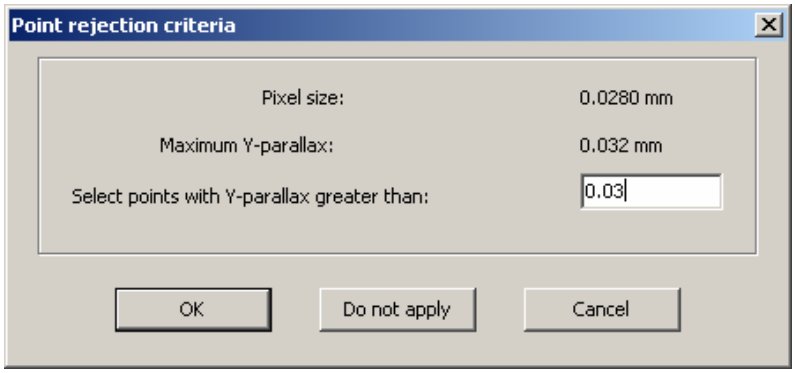


Fig.40 Points rejection

To delete all such points, select the **Delete "bad"** option from the **Points** menu. To delete points one by one, select the point in the list and push the button or select the **Delete**

option from the **Points** menu or press **Ctrl-D** hot keys. If you need to delete control point, it is possible if it was measured on only one image. After that it becomes a tie point if it was used in the relative orientation. Also you can delete points on all images using the command **Delete on all images**. It is available if the selected point belongs to at least two images. If the point is control or check, it is deleted on all images, except the one, where it was measured first. Once a point is deleted you get a message with a list of stereo pairs needed to recalculate the relative orientation for.

To show the **Status** window, use command **Orientation | Status** or push the icon.

3.4.3.2 *Accuracy control by adjacent models tying (in triplets)*

It is recommended to provide images relative orientation accuracy control by comparing the discrepancies of point's measurements on adjacent stereopairs (models) (in overlapping zone of three neighboring images of one strip – triplets).

Such kind of control allows to detect the discrepancies in models even on measuring stage and not to get back to relative orientation after the block adjustment.

You can perform such accuracy control in **PHOTOMOD AT** module by merging of two adjacent models into the single model. For that select the menu command **Orientation | Model ties (prev. model)** or **Orientation | Model ties (next model)**, or use hot keys **Ctrl-Alt-P** and **Ctrl-Alt-N** respectively in the **Measuring tie points** window on the appropriate tab of **PHOTOMOD AT** module.

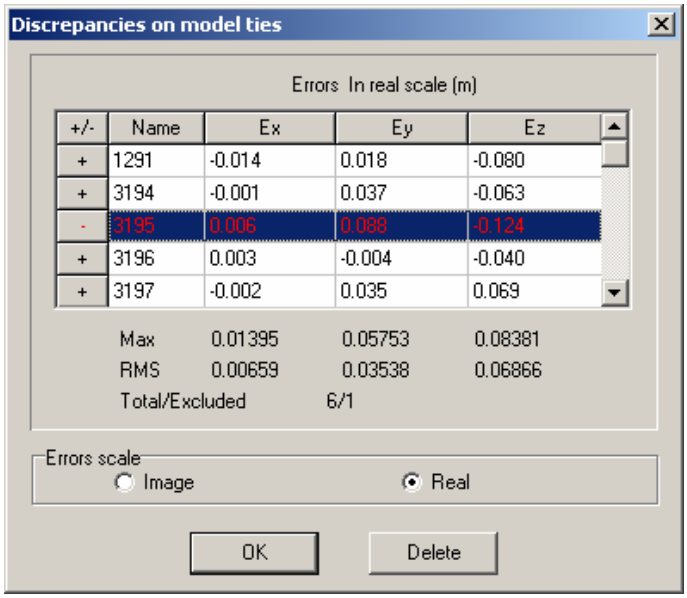


Fig.41 Errors from adjacent models

At the appeared **Discrepancies on model ties** window the list of all tie points located in overlapping zone is displayed, showing the discrepancies Ex, Ey, Ez in their X, Y, Z coordinates calculated from two adjacent models. The coordinate's discrepancies could be measured in image scale (mm) or real scale (m), depending on the option **Errors scale**. The **Real scale** option is active if you input survey scale factor in **PHOTOMOD Montage Desktop** module (**Project | Properties | Coordinate system | Scale** field, see the appropriate User Manual).

Mouse click on the selected point line in the list causes marker moving to the point position on images and lenses and also selecting this point line in the lower list in the **Measuring tie points** window.

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Listed points could be sorted by X, Y and Z discrepancies or by point name (number), using mouse click on the appropriate column header.

You can exclude any point from the procedure of tying models by setting the corresponding "**+/-**" button to the "**-**" state in the leftward column on the table. At that the point is highlighted by red color in the list. To delete a point from the current stereo pair, select it in the table and push the **Delete** button.

3.4.4 Working with block scheme

To make the procedure of measuring points more convenient, you can use the scheme that shows the frames of the block images and the locations of the measured points. To show the scheme, push the button on the **Actions** panel of the **Strip ties** or **Tie points measurements** tabs of the **PHOTOMOD AT** window. Besides you can open the **Block scheme** from the **Measuring tie points** tab while processing the project of scanner monoblock type, see the chapter 4.2 Processing of scanner monoblock in PHOTOMOD AT.

The **Block Scheme** dialog box appears.

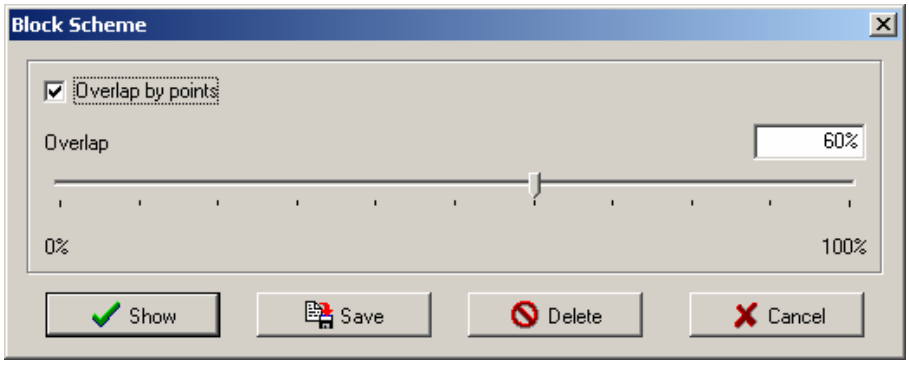


Fig.42 Block scheme parameters

The **Overlap by points** option means that for stereo pairs which have the relative orientation procedure done the overlap value is determined using tie points. If this option is off or for some stereo pairs without relative orientation, the side overlap is equal to the value you can set by shifting the **Overlap** slider. After pushing the **Show** button, the **Block scheme** window opens (Fig.43).

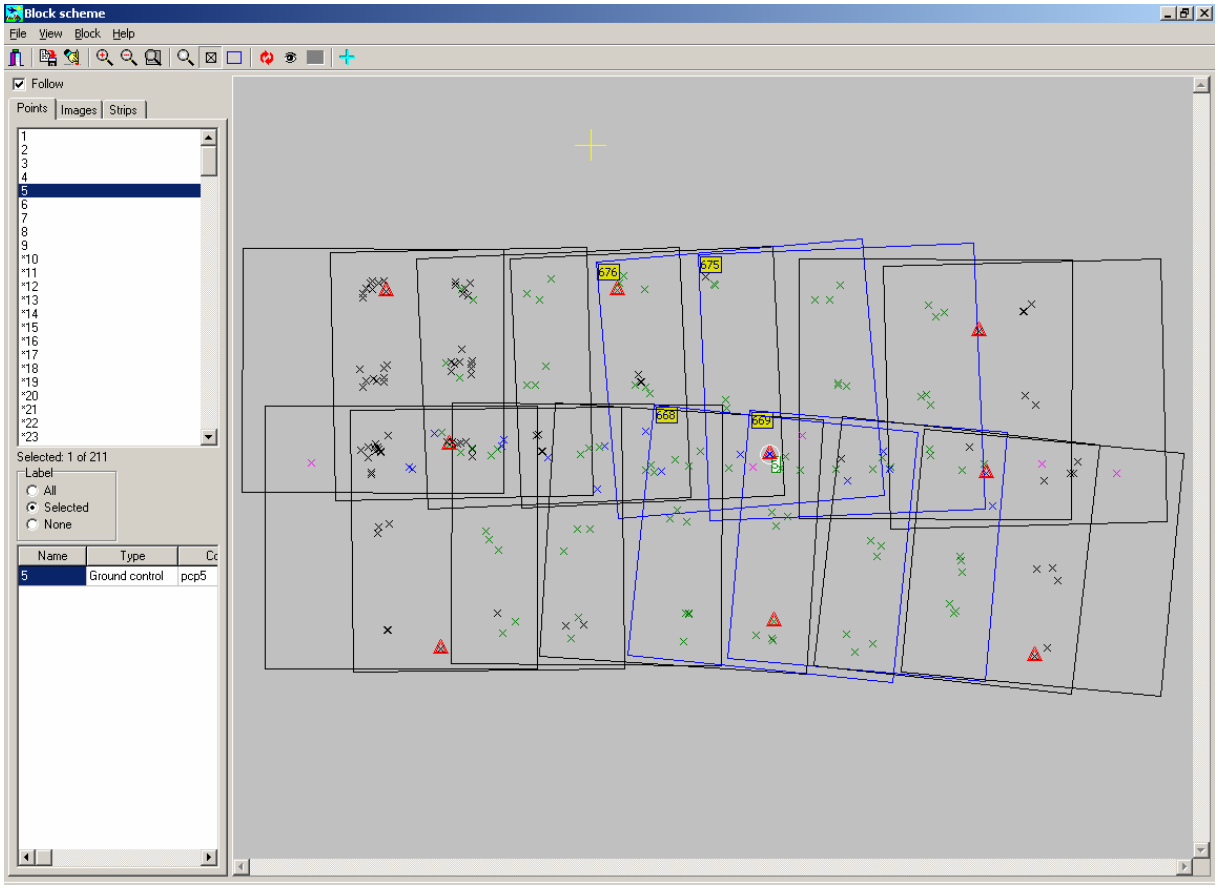


Fig.43 Block scheme window

The **Block scheme** window contains:

- the plot of the scheme in the right part of the window;
- the panel with tabs **Points**, **Images** and **Strips** in the left part of the window showing the list of all measured points and images in the upper part of the panel and the list of the points and images currently selected in the lower part.

The panel contains three tabs: **Points**, **Images** and **Strips**. Each of them shows in upper window the list of points, images and strips respectively. At that in lower window there is the data about selected images, points and strips. The objects selected are highlighted by blue color.

To select images, click the **Images** tab and select the images you want in the list of images. The names of the selected images are listed in the lower part of the panel together with the numbers of points measured on them. Boundaries of the selected images are shown in blue color on the plot and the points measured on the selected images are marked by small white circles and labeled by their names.

You can also select images directly in the scheme. For this, push the button (**Images selection mode**) at the upper button bar and click the image boundary.

Using radio buttons in the **Label** panel you can show on the scheme names of:

- all images - **All** button;
- selected images - **Selected** button;
- no names - **None** button.

Using radio buttons in the **Select points** panel you can choose on the selected images:

- all measured points - **All** button;
- all tie points (common for all selected images) - **Tie** button;

- no points - **None** button.

You can select points and strips from the list on the **Points** and **Strips** tabs respectively, in the same way as selecting images.

You can also select points directly in the scheme. For this, push the button (**Points selection mode**) at the top of the window and click the point. To select a group of points, draw a rectangle around needed points by mouse dragging.

Using radio buttons in the **Label** panel you can show on the scheme names of:
- all measured points - **All** button;
- selected points - **Selected** button;
- no names - **None** button.

If the **Follow** option (**Follow** checkbox in the upper left part of the window) is on, selection of points, images and strips causes selection points, images and strips located on them or containing them.

You can change the scale of the scheme in zoom mode (when the button **Zoom mode** is pushed, or **Zoom** menu item is selected).

To change the scheme scale, use the following icons of upper button bar or commands from the **Zoom** menu:

(**Zoom in**) – to zoom in the scheme

(**Zoom out**) – to zoom out the scheme

(**Restore original**) – to restore the original scale.

Besides, you can enlarge some part of the block scheme, selected be the rectangle drawn by mouse.

To view changes in block scheme window push the button (**refresh block scheme**).

To adjust the marker parameters push the button or select menu command **Selection | Marker parameters** which opens the appropriate window (see the chapter 3.5.3 Marker parameters).

The (**Show point**) button is used for viewing the point on images, where it is measured (Fig.44). Press **Esc** to close the window showing point on images.

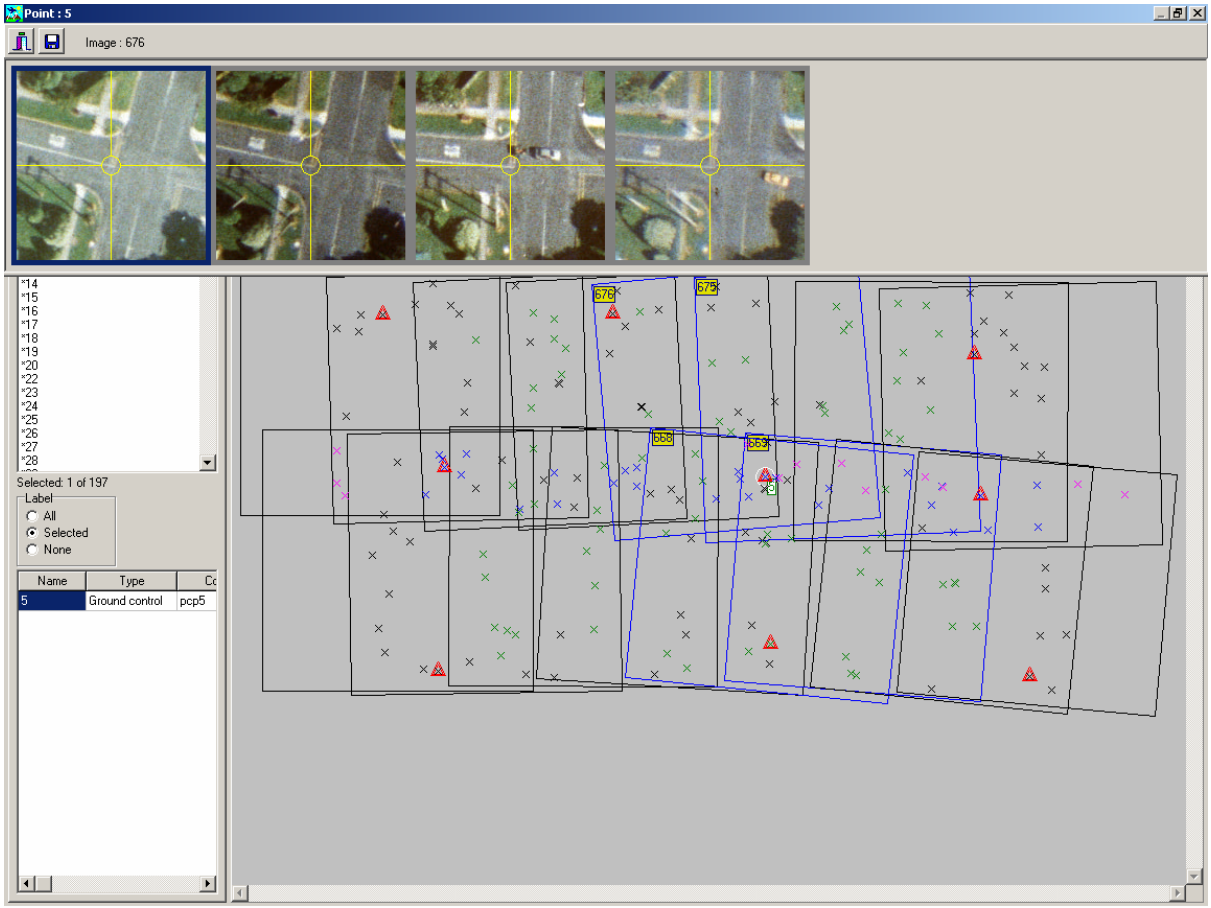


Fig.44 Point measured on several images

Measured point could be also viewed or edited on all images where it is shown by pushing the button (**Edit point on images**). After that the **Edit point** window opens, where you can see point position on different images of the block (see the chapter 3.4.5 Point editor window).

To save current ties and images overlaps and also to consider them for displaying of the block scheme in **PHOTOMOD Montage Desktop** module, use menu command **File | Save scheme** or the icon (**Save scheme**).

Menu command **File | Delete scheme** or the icon causes displaying the block of images in **PHOTOMOD Montage Desktop** module without taking the overlaps into account.

Note. Block scheme is used also in module of automatic ties measurements PHOTOMOD AAT, see corresponding User Manual

Push the button (**Close**) to close block scheme window.

3.4.5 **Point editor** window

When you measure points in images or strip overlap (working in windows opened from the tabs **Strip ties** or **Tie points measurements**), you can add or edit them on all images where they exist. This procedure is available in the **Point editor** window opened by the button (**Add/Edit on all images**) or (**Show/Edit on all images**) in lower button bar of the **Strip**

ties window (see the chapter 3.4.1 Interstrip ties) or the **Measuring tie points** window (see the chapter 3.4.2.2 Tie points measurements window). You can also open the **Edit point** window showing selected point on block images from Block scheme window, see the chapter 3.4.4 Working with block scheme.

After that **Point editor** window showing the point on all images appears:

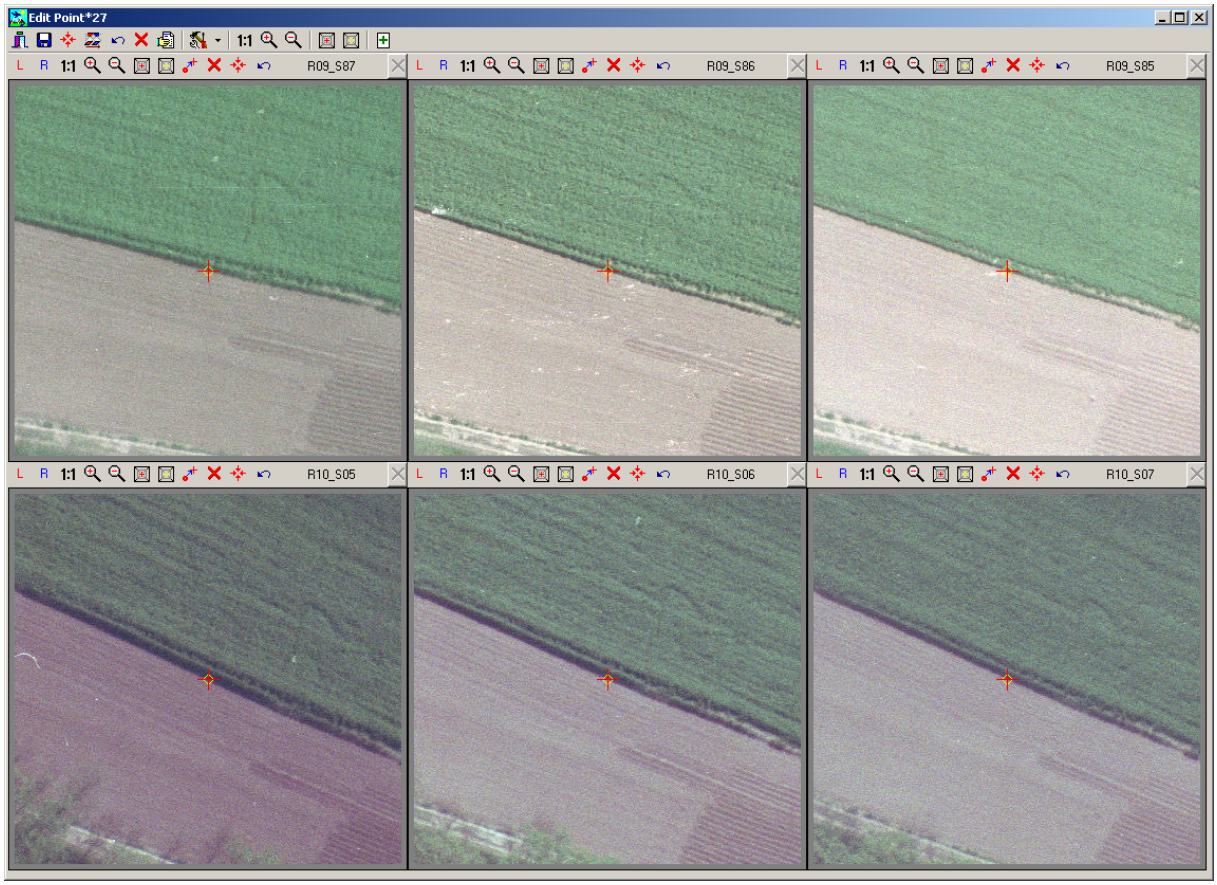


Fig.45 Editing the point on all images

The window allows to change point's location and re-measure it on some image "manually" or automatically using the correlator. Use the button bar above each image and common upper button menu for working in this window.
Upper menu of the window is common for all images and have the following functions:

- exit from the window without changing measurement results

- exit with results saving

- correlate all images with left one (at first you should assign one of the images as a left using the button above it), is duplicated by **Ctrl-Space** hot keys.

- open stereocomparator window (see the chapter 3.4.2.6.2 Stereocomparator mode). Before launching stereocomparator you should position the cursor on the needed point on each stereopair image. Duplicated by **Alt-S** hot keys.

- restore initial measurement of point's coordinates on all images

- delete on all images – deletes the point and its measurements on all images

- relative orientation and triplet check – opens a window with correlation results and errors in triplets on the given point in image scale (Fig.46). Upper panel of this window

contains the list of stereopairs with selected point and vertical parallax values and also maximal and RMS residuals in it. In the lower table there are measurements errors for the point in triplets.

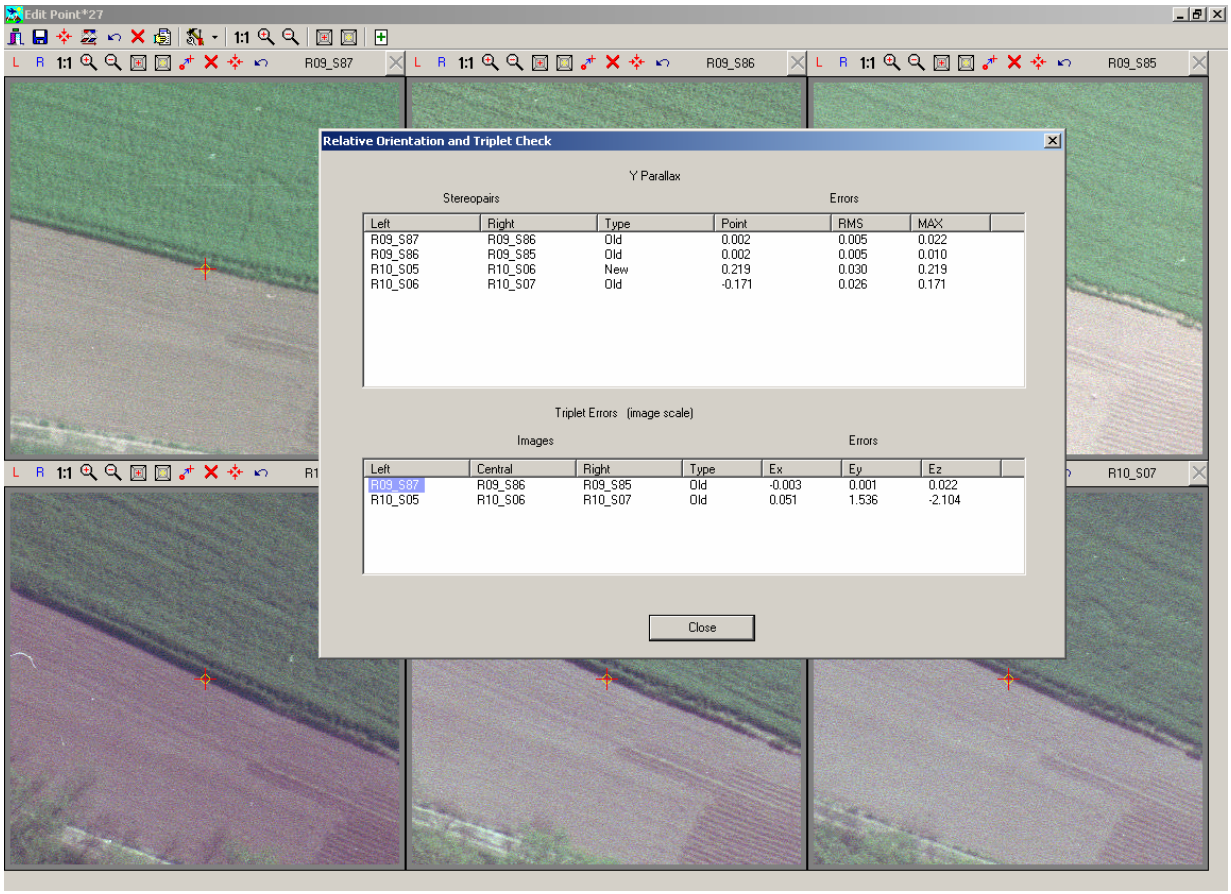


Fig.46 Relative orientation and triplet check

- settings – opens drop-down menu allowing to set up the color of marker, points, errors, and correlator parameters as well

- show all images in 1:1 scale. Duplicated by **Alt-1** hot keys.

- zoom in images in all windows. Duplicated by **Alt-*** hot keys.

- zoom out images in all windows. Duplicated by **Alt-/** hot keys.

- to move image center to the marker position on all of the images. Duplicated by **Alt-M** hot keys.

- to move image center to the point position on all of the images. Duplicated by **Alt-P** hot keys.

- add images – opens the window for strips and images selecting, to open them in the **Point editor** window. Duplicated by **Alt-A** hot keys.

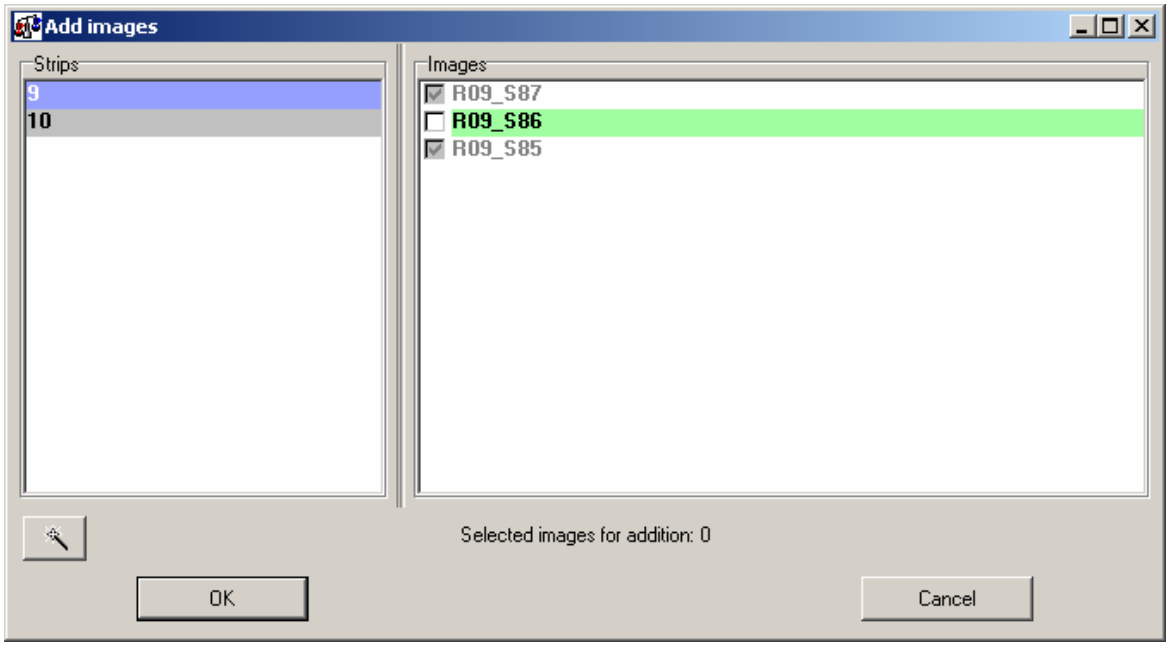


Fig.47 Adding images to the **Point editor** window

You can add images to the **Point editor** window, where the point is located but not measured, using the **Add images** list. Light green color indicates strips and images, which may contain the point, and you can add them by the button (**Select images automatically**).

To start the work select left and right images by pushing or buttons and edit the point using the button bar above the image. This button bar is intended for the following operations:

and - left and right stereopair images selection (to measure point using stereo comparator or correlator)

- image zooming

- center marker – put image center to marker position on the image. Duplicated by **M** key

- center point – put image center to point position on the image. Duplicated by **P** key

- move point to marker position

- delete measuring

- correlate with left (at first you should assign one of the images as a left using button above it). Duplicated by **Space** key.

- restore initial position

- close image – button is located in upper right corner of the image and allows to close the image if there are no measured points.

3.5 *Working with raster images*

3.5.1 Image view windows

User works with raster images during the following processing steps:

- Interior orientation,
- Measuring of GC points,
- Interstrip ties,
- Tie points measurements.

When processing a single raster image, there are the main raster window and the lens window on the screen. When processing a stereo pair, two main raster windows and two lens windows are displayed.

To change a window size, drag a window frames by the mouse.

To zoom in/out an image, use the "*****" or "**/**" keys of the keyboard or the slider located near the image.

To position the marker to some image point, click it by the mouse.

When two markers are positioned simultaneously in both images of a stereo pair **the approximate marker stereo positioning** is achieved by mouse double click on one of the images. In this case the marker is positioned precisely on the point of the image that has been clicked. On the other image the marker is automatically positioned on the neighbor area of the point that is the matching point for the one clicked in the first image. This function is suitable for measuring tie points using the correlator.

Note. The approximate marker stereo positioning becomes available when at least one point has been measured on a stereo pair

To move the marker, use the "arrow" keys of the keyboard.

To position the marker to a measured point, use double click in the neighbor area of the point in any of the stereo pair images. The markers in both stereo pair images will be strictly positioned at the measured point.

To center an image relatively to the marker position in a main raster window or in a lens, click the corresponding ("Marker") button. When the **Shift** key is pressed, the image in a lens window is centered automatically.

To scroll a raster image in a window, use the scroll bars at the frame of the window. To show the scroll bars in a lens window, click the corresponding ("Scroll") button.
To move the image in the window in panning mode use mouse along with pressed **Alt** key.

The current marker coordinates are displayed near the main raster window. The coordinates are displayed in "real" (geodetic) coordinate system in selected units, and in the image coordinate system in pixels (below).

Pressing the **Ctrl-L / Ctrl-R** keys allows to position the lens window approximately in the left/right window relatively to the marker position in the right/left window.

3.5.2 Adjusting brightness and contrast

When working with a raster image you can adjust its radiometry and change the marker parameters.
To adjust an image radiometry, select the **Brightness/Contrast** option from the **Options** menu or push the icon.

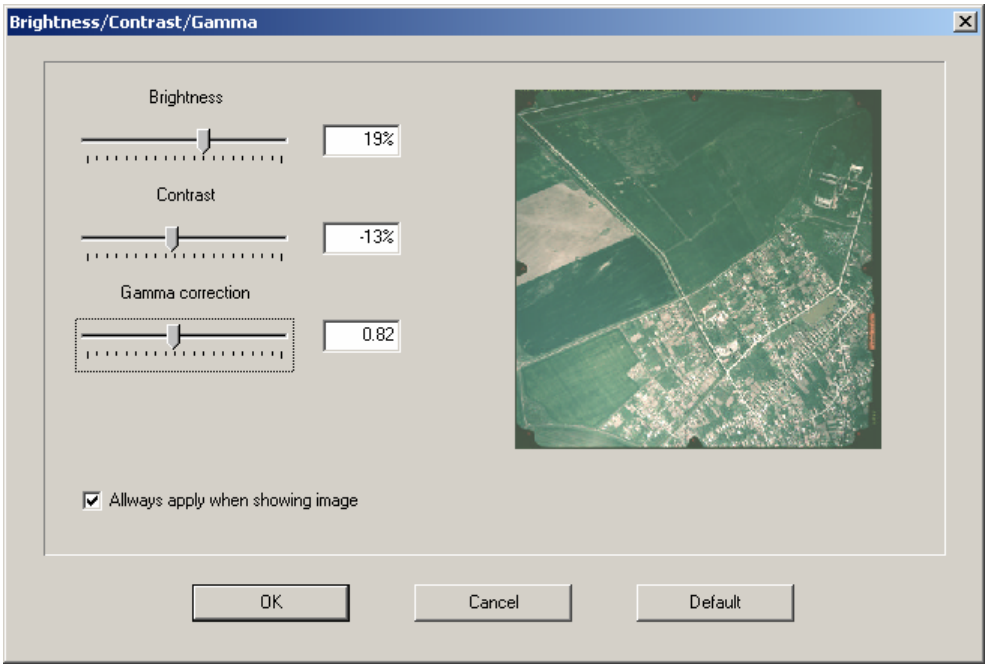


Fig.48 Brightness adjustment

At the **Brightness | Contrast | Gamma** window you can adjust the image brightness, contrast and gamma using the corresponding sliders or typing their values in the text boxes. To keep the current settings valid for subsequent image appearances, mark the check box **Always apply when showing image**. Use the **Default** button to set all parameters to the default values.

3.5.3 Marker parameters

To change the marker parameters, select the **Marker** option from the **Options** menu or push the icon to open **Marker parameters** window. Use **Marker parameters** window for changing color, size and shape of the marker.

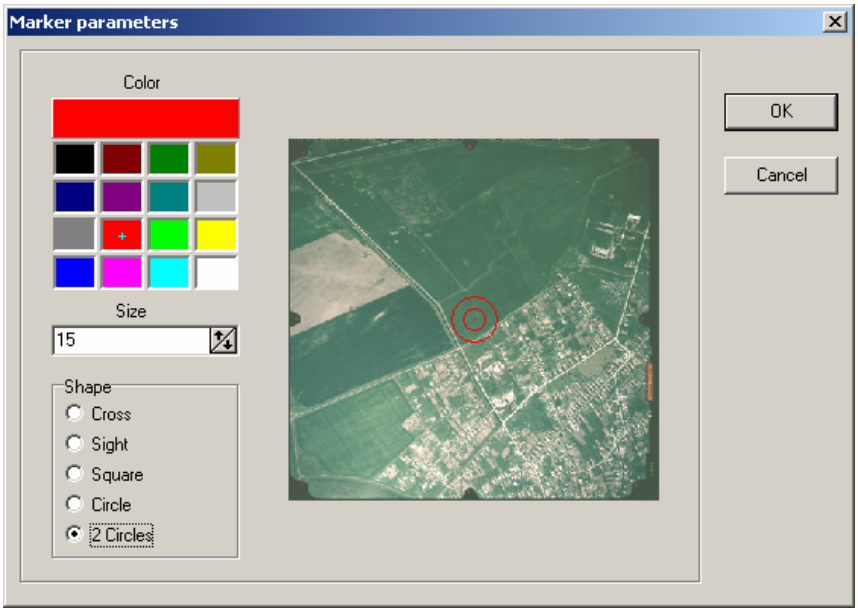


Fig.49 Marker parameters

3.5.4 Types of points and their visualization on images

In **PHOTOMOD AT** module the following signs are used for different point's types, shown and measured on the images:

Ground control.

- Point measured on the only one image is shown by the sign
- Points measured on several images are shown by the sign

Check.

- Point measured on the only one image is shown by the sign
- Points measured on several images are shown by the sign

Tie.

- Point measured on the only one image is shown by the sign
- Points measured on several images are shown by the sign

Color and thickness of tie points signs is set up in the window opened using menu command **Options | Display styles** in **Tie points measurements** window, see the chapter 3.4.2.4 Measurements settings and types of tie points fixation.

4. Project types

PHOTOMOD system works with two types of projects (based on the source image geometry) – **Central projection** (images acquired by photo cameras) and **Scanner images** (images acquired by scanning devices such as SPOT, ASTER, IRS, IKONOS etc.). The project type is selected in **PHOTOMOD Montage Desktop** module while the project creating (see the corresponding User Manual).
While processing central projection images (acquired by photo camera) **PHOTOMOD** works with images block (**Block** project subtype) or single image (project subtype **Single image**). Images block is subject of full photogrammetric processing by all needed **PHOTOMOD** modules. In case of single image it is undergoing the interior orientation, georeferencing,

adjustment and ortho-rectification if the “external“ DEM is available (see the chapter 4.2 Processing of single central projection images in PHOTOMOD AT and also **PHOTOMOD Montage Desktop**, **PHOTOMOD Solver** and **PHOTOMOD Mosaic** User Manuals).

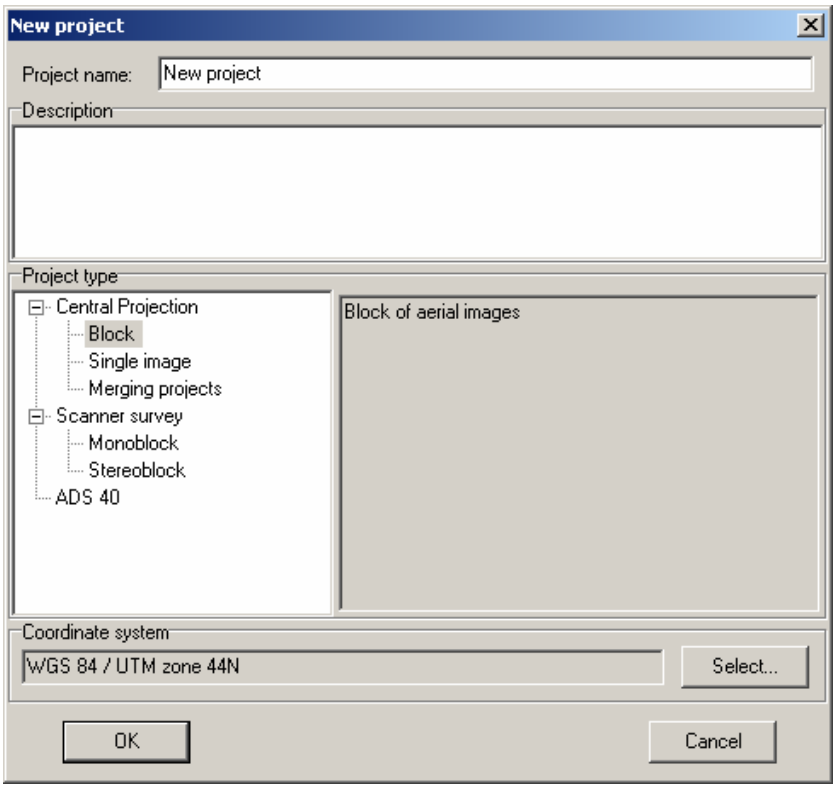


Fig.50 Project type selection

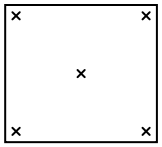
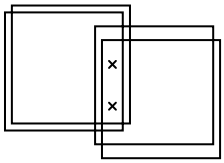
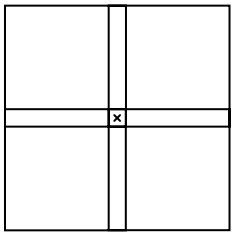
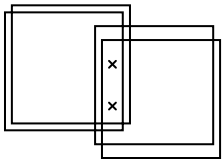
Scanner survey project type includes two subtypes: **Monoblock** and **Stereoblock**. More details about projects types and kinds of images for processing see in **PHOTOMOD Montage Desktop** User Manual.

If the block images compose valid stereopairs, create a project of **Stereoblock** subtype. Project of **Monoblock** subtype should contain images with some overlap, but not allowing to perform stereo processing.

In case of scanner stereopair or set of stereopairs (project type – **Stereoblock**) the full photogrammetric processing by all needed **PHOTOMOD** modules is performed (see also the chapter 4.4 Processing of scanner stereoblock in PHOTOMOD AT). When processing images monoblock you can measure ground control points and ties, see the details in the chapter 4.4 Processing scanner monoblock in PHOTOMOD AT, as well as **PHOTOMOD Montage Desktop** User Manual.

Adjustment of scanner mono and stereo blocks is executed in **PHOTOMOD Solver** module, see the appropriate **User Manual**.

4.1 *Number of GCP necessary for space images processing in PHOTOMOD*

Project type / Algorithm		Monoblock	Stereoblock
Rigorous	GCP	Resurs DK – 6 (points per image) FORMOSAT -2 – 4-6 EROS A,B – 4-6 KOMPSAT-2 – 4-6 SPOT 1-4 – 4-6 SPOT 5 – 4 TERRA/ASTER – 4-6 	KOMPSAT-2 – 4-6 SPOT 1-4 – 4-6 SPOT 5 – 4 TERRA/ASTER – 4-6 GCPs per image (their number could be less if tie points measured in triple or quadruple overlap are used) 
	Check	3-5	1-2 (not less than 5 for block)
	Tie	3-4 in double overlap area, if there is triple or quadruple overlap – measure some points there 	3-4 in quadruple overlap
RPC	GCP	QuickBird - 1-4 OrbView-3 – 1-4 WorldView-1 – 1-4 GeoEye-1 – 1-4 IKONOS - 1-4 KOMPSAT-2 – 4-5 Cartosat-1 (IRS P5) – 4-5 ALOS (PRISM) – 1-4	GeoEye-1 – 1-4 IKONOS - 1-4 KOMPSAT-2 – 4-5 Cartosat-1 (IRS P5) – 4-5 ALOS (PRISM) – 1-4 per image (their number could be less if tie points measured in quadruple overlap are used) 
	Check	3-5	1-2 (not less than 5 for block)
	Tie	3-4	3-4 in quadruple overlap
Generic	GCP	Landsat 7/ETM+ IRS-1C, 1D/PAN IRS P6 (Resourcesat-1) ALOS (AVNIR 2) - 7-10 - minimum with which you can start adjustment	Landsat 7/ETM+ IRS-1C, 1D/PAN IRS P6 (Resourcesat-1) ALOS (AVNIR 2) - 7-10 - minimum with which you can start adjustment
	Check	5-7	5-7

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	Tie	Not necessary to measure	Not necessary to measure

4.2 *Processing of single central projection images in PHOTOMOD AT*

For processing of single image in central projection you should just input control points and measure them. The minimum number of control points is 3 (3 GCPs or 2 GCPs and the projection center). Then you also can perform interior orientation.
Then single images of central projection are adjusted in **PHOTOMOD Solver** (see the appropriate **User Manual**).

Afterwards you can orthorectify processed central projection image in **PHOTOMOD Mosaic** module using DEM if available (see **PHOTOMOD Mosaic** and **PHOTOMOD Montage Desktop** User Manuals).

4.3 *Processing of scanner monoblock in PHOTOMOD AT*

Scanner block, containing single image or several images without stereo overlap, is processed in **PHOTOMOD** system in projects of **Scanner survey | Monoblock** type.

This type of projects is processed in **PHOTOMOD AT** for GCP coordinates input and measuring them on images, (on **Measuring GC points** tab, see the chapter 3.3 Ground control points input).

Tie points between strips and images in scanner monoblock are measured on the next step – on the **Measuring tie points** tab shown below:

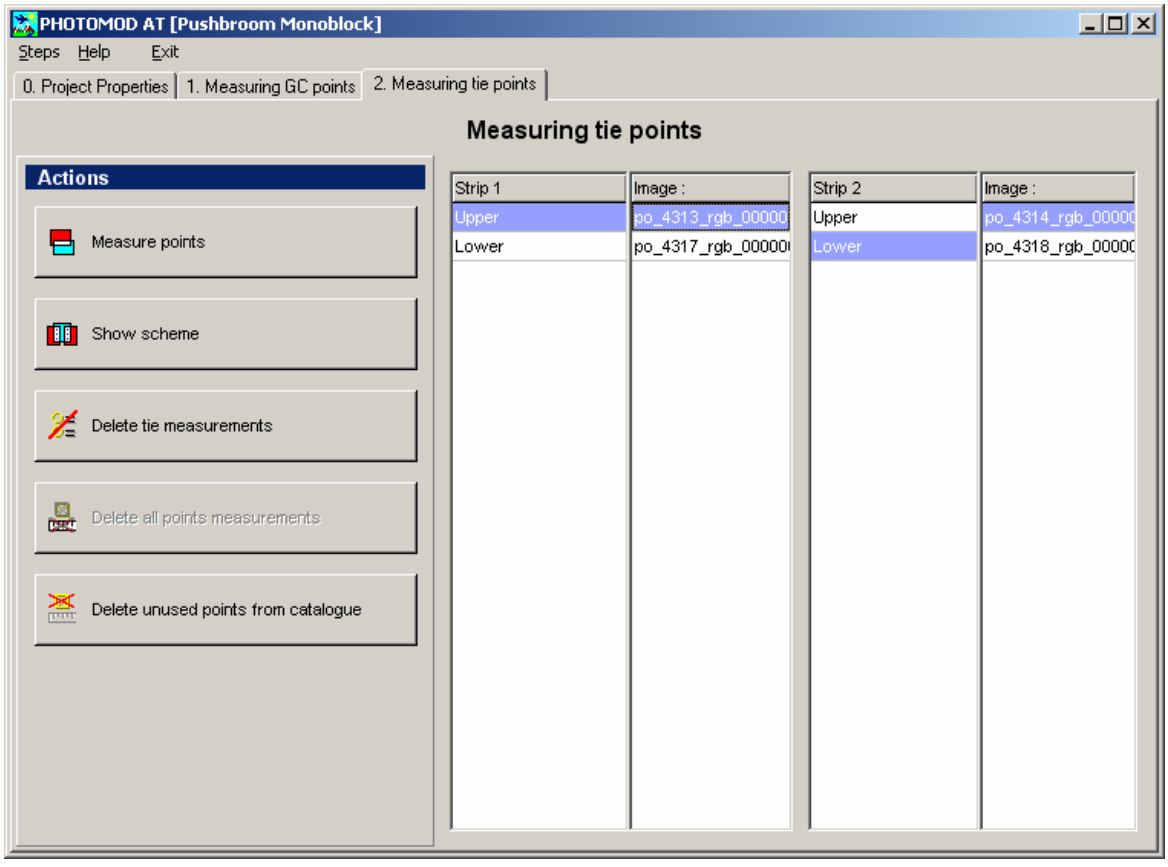

Fig.51 **Measuring tie points** tab for scanner monoblock

This page contains two lists of images: **Strip 1** and **Strip 2**. Strip names are shown above the top left corner of each list.

To select strip or image click it in the appropriate list.
If the same strip and its overlapping images are selected in both lists, then tie points are measured in the vertical overlapping area between the images. At that the images are located horizontally in window appeared after pushing the button and you can process them as described in the chapter 3.4.2.2 Tie points measurements window.

If you selected upper and lower strips in the lists and overlapping images from them, then you can measure tie points in the horizontal overlapping area between the images and strips after pushing the button . At that in appeared window the images are shown vertically and are processed as described in the chapter 3.4.1 Interstrip ties.

Note. The ***button is inactive, if the same strips and images are selected***

Note. To view already measured tie points on the block scheme push the ***button***

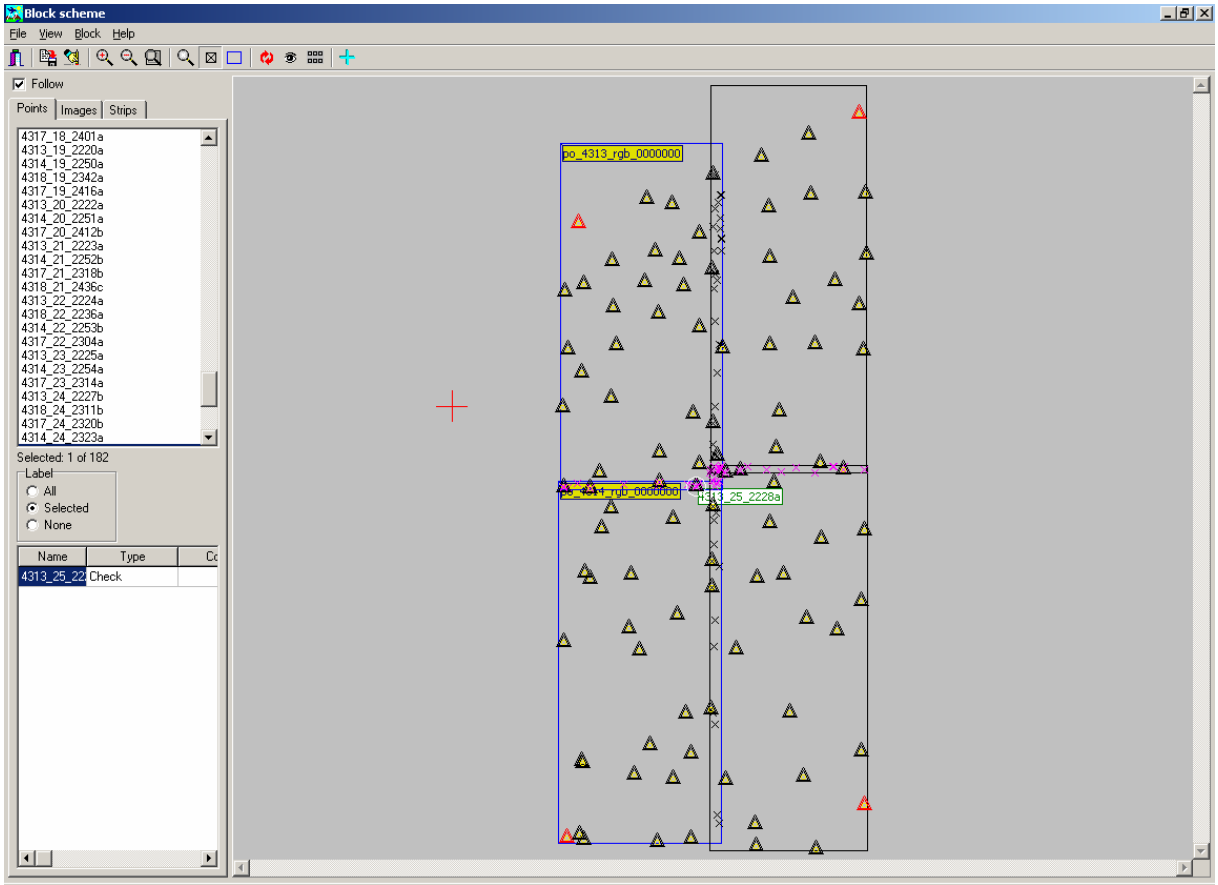

Fig.52 Block scheme of scanner images monoblock ties measurement

See the chapter 3.4.4 Working with block scheme for the details about work with **Block scheme**.

When tie points measurements is complete in **PHOTOMOD AT**, you can start block adjustment in **PHOTOMOD Solver** module, see the description in the appropriate **User Manual**.

Refer to **Space Imagery Processing** User Manual for detailed description of the whole procedure of space images processing in **PHOTOMOD** system.

4.4 *Processing of scanner stereoblock in PHOTOMOD AT*

Scanner images with stereo overlap are supposed to be orthorectified and used for orthomosaic creation in **PHOTOMOD Mosaic** module (see appropriate User Manual) using DEM and ground control points (GCP). It is recommended to measure (recognize) tie points in overlapping areas of stereoblock images, that could improve block adjustment results.

Scanner stereo blocks (stereopairs and stereopair blocks) are processed in **PHOTOMOD** system as follows:

1. Create project in **PHOTOMOD Montage Desktop**. The project type should be **Scanner survey | Stereoblock**
2. Add images (**Block forming** stage in **PHOTOMOD Montage Desktop**).
3. Switch to “Aerial triangulation“ stage and start **PHOTOMOD AT** module.
4. Enter coordinates of ground control points (**Measuring GC points** tab), see the chapter 4.4.1 GCP input and measurement.
5. Measure ground control points on the images (**Measuring GC points** tab), see the chapter 4.4.1 GCP input and measurement.
6. Make relative orientation (**Measuring tie points** tab), see the chapter 4.4.2 Measuring points in stereo mode.
7. Go back to **PHOTOMOD Montage Desktop** and start further processing in other **PHOTOMOD** modules (**Solver**, **DTM**, **StereoDraw** etc.).

Note. See PHOTOMOD Montage Desktop User Manual for information about supported scanner imagery formats

Refer to **Space Imagery Processing** User Manual for detailed description of the whole procedure of space images processing in **PHOTOMOD** system.

4.4.1 GCP input and measurement

In case of pushbroom imagery processing, use the following **PHOTOMOD AT** main window tabs. The tab **Measuring GC points** allows ground control and check points coordinates input and their measurement on the images, as described in the chapter 3.3 Ground control points input.

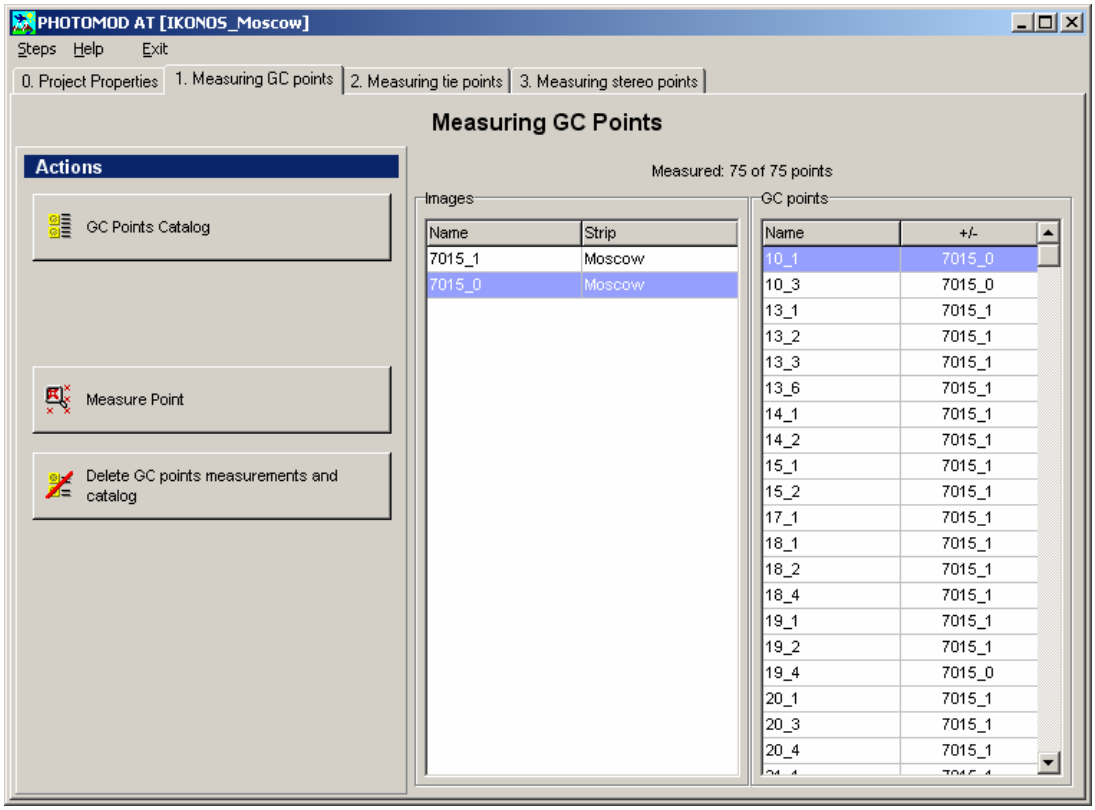

Fig.53 GCP measurement on scanner stereopair (IKONOS)

If the project consists of several strips, you may measure inter-strip tie points on the **Measuring tie points** tab. If the project contains the only stereopair, you should start tie points measuring, see the chapter 4.4.2 Measuring points in stereo mode.

4.4.2 Measuring points in stereo mode

The tab **Measuring stereo points** is intended for GCPs/CPs and tie points measurement in stereoscopic mode.

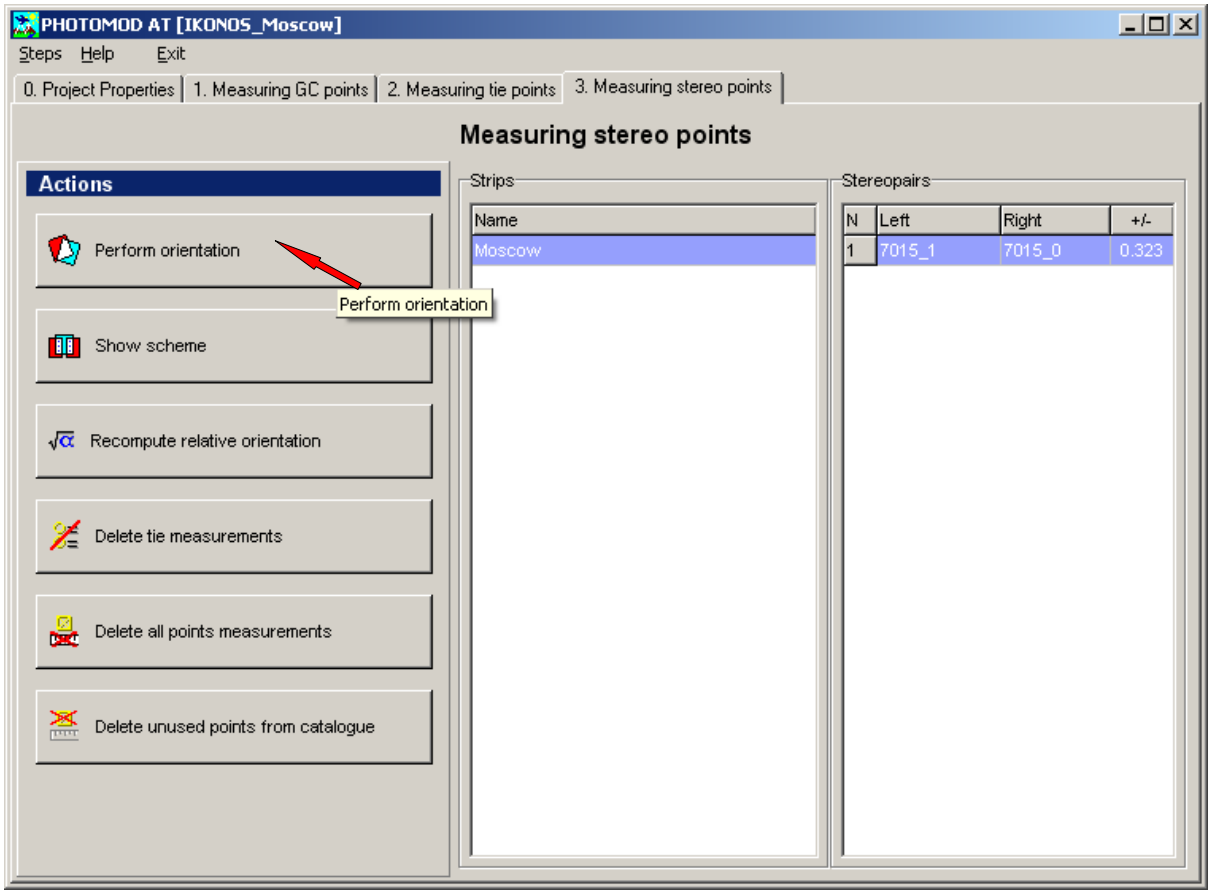

Fig.54 Start of measuring points in stereo mode (IKONOS stereopair)

Refer to the chapter 3.4.2 Tie points measurements for details on points measurements.

After point's measurements and performing of orientation you should go back to **PHOTOMOD Montage Desktop** and start further processing in other **PHOTOMOD** modules (**Solver**, **DTM**, **StereoDraw**, etc.).

5. Import of measurements

In case of building and adjustment of the block of images by third-party software you can load the data (coordinates of control and tie points and exterior orientation parameters) to the **PHOTOMOD** system for further processing. **PAT-B** and AeroSys formats are used for the data exchange. The whole procedure and PAT-B files examples are described in details in chapter **Import of measurements** in **PHOTOMOD Montage Desktop** User Manual.

6. Database tables used by PHOTOMOD AT

6.1 *Tables description*

All **PHOTOMOD AT** data is stored in the database tables (resource with .db extension) that are described below. You can use **PHOTOMOD Explorer** window (see Fig.55) to open the list of **PHOTOMOD AT** data tables in the following way: right mouse click on the icon in the right lower screen corner and then select the **PHOTOMOD Explorer** option in popup

menu appeared. See **PHOTOMOD Overview** User Manual for **PHOTOMOD Explorer** details.

There are the following names of database fields in **PHOTOMOD** system:

- Cnn - text field of nn length;
- I - integer (4 bytes);
- N - float;
- S - short integer (2 bytes);
- D - date;
- T - time;
- A - auto increment (4 bytes integer, is automatically increased by 1 whenever a record is added, is always primary index).

Primary indexes are typed by **bold**.

Cameras table "cameras.db"

CODE_CAM	I	Unique camera index
NAME	C16	Camera name
TYPE	S	Camera type (is not used in the current version)
CALIBR_DATE	D	Calibration date
DESCRIPT	C255	Camera description
MEASURE_CODE	I	Code of measurement units
FOCUS	N	Focal length
X0	N	X - coordinate of the principal point
Y0	N	Y - coordinate of the principal point
CALIBR_TYPE	S	Type of calibration
FIDUCH_CODE	I	Type of fiducial marks
DX	N	Fiducial distance in X direction
DY	N	Fiducial distance in Y direction
DISTOR_TYPE	I	Type of distortion
SYM_X	N	X - coordinate of the point of symmetry
SYM_Y	N	Y - coordinate of the point of symmetry
D1	N	Coefficient of distortion (if distortion is defined by the formula)
D2	N	Coefficient of distortion (if distortion is defined by the formula)
D3	N	Coefficient of distortion (if distortion is defined by the formula)
D4	N	Coefficient of distortion (if distortion is defined by the formula)
D5	N	Coefficient of distortion (if distortion is defined by the formula)

Distortion table "distcam.db"

CODE_DIST	A	Unique table index
CODE_CAM	I	Foreign index of the table
DIST_TYPE	I	Data type
R	N	Radius
D1	N	Correction
D2	N	Correction
D3	N	Correction

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D4	N	Correction

Fiducial marks coordinates table "coordcam.db"

CODE_COORD	A	Unique table index
CODE_CAM	I	Foreign index of the table
X	N	X coordinate
Y	N	Y coordinate

Images information table "images.db"

CODE_IM	A	Unique table index
ROUTE_ORDER	I	Ordinal number in the strip
ROUTE	I	Foreign index, number of the strip
NAME	C32	Name
DESCRIPTION	C32	Description
FILENAME	C255	File name
PATH	C255	Folder
RASTER_TYPE	I	File format/rotation
IMG_WIDTH	I	Width of the raster image
IMG_HEIGTH	I	Height of the raster image
BITSPP	S	Number of bits per pixel
FILEDATE	D	File date
FILETIME	T	Time of file creation
FILESIZE	I	File size
CODE_CAM	I	Foreign index, number of the camera
MEASURE_CODE	I	Code of measurement unit
DISTOR_TYPE	I	Type of distortion
INT_OR	S	Type of interior orientation
A1	N	Coefficient of transformation pixel→mm
A2	N	Coefficient of transformation pixel→mm
A3	N	Coefficient of transformation pixel→mm
B1	N	Coefficient of transformation pixel→mm
B2	N	Coefficient of transformation pixel→mm
B3	N	Coefficient of transformation pixel→mm
C1	N	Coefficient of transformation pixel→mm
C2	N	Coefficient of transformation pixel→mm
X	N	Projection center coordinate
Y	N	Projection center coordinate
Z	N	Projection center coordinate
WX	N	Accuracy of projection center coordinate
WY	N	Accuracy of projection center coordinate
WZ	N	Accuracy of projection center coordinate
A	N	Absolute orientation angle
OM	N	Absolute orientation angle
KAP	N	Absolute orientation angle
XC	N	Calculated coordinate of projection center
YC	N	Calculated coordinate of projection center
ZC	N	Calculated coordinate of projection center
AC	N	Calculated absolute orientation angle
OMC	N	Calculated absolute orientation angle
KAPC	N	Calculated absolute orientation angle
BRIGHT	I	Brightness correction for display
CONTRAST	I	Contrast correction for display

GAMMA	I	Gamma correction for display
INVERT	I	Inversion for display
ZONE_X0	I	X coordinate of zone 1
ZONE_Y0	I	Y coordinate of zone 1
ZONE_X1	I	X coordinate of zone 2
ZONE_Y1	I	Y coordinate of zone 2
ZONE_X2	I	X coordinate of zone 3
ZONE_Y2	I	Y coordinate of zone 3
ZONE_X3	I	X coordinate of zone 4
ZONE_Y3	I	Y coordinate of zone 4
ZONE_X4	I	X coordinate of zone 5
ZONE_Y4	I	Y coordinate of zone 5
ZONE_X5	I	X coordinate of zone 6
ZONE_Y5	I	Y coordinate of zone 6
ZONE_SIZE	I	Zone size

Fiducial marks coordinates measurements table "fiducial.db"

CODE_IM	I	Foreign index
CODE_COORD	I	Foreign index
X	N	Fiducial mark coordinate in pixels
Y	N	Fiducial mark coordinate in pixels

Ground control points table "geodez.db"

CODE_G	A	Unique index of point
NAME	C8	Name
TYPE	I	Type of point
X	N	Coordinate
Y	N	Coordinate
Z	N	Coordinate
WX	N	Weight (reliability) of coordinate
WY	N	Weight (reliability) of coordinate
WZ	N	Weight (reliability) of coordinate
COMMENT	C32	Comment
XC	N	Calculated coordinate
YC	N	Calculated coordinate
ZC	N	Calculated coordinate

Measured points table "points.db"

CODE_G	I	Foreign index, number of point
CODE_IM	I	Foreign index, number of image
CODE_IMTO	I	Foreign index, number of image where the point was identified/correlated
CORR	N	Correlation value
XP	N	Pixel coordinate
YP	N	Pixel coordinate

Stereo pairs table "stereo.db"

CODE_IML	I	Foreign index, number of left image
CODE_IMR	I	Foreign index, number of right image
REL_OR_TYPE	I	Type of relative orientation

ROUTE	I	Foreign index, number of strip
ALFA_LEFT	N	Relative orientation angle
KAPPA_LEFT	N	Relative orientation angle
ALFA_RIGHT	N	Relative orientation angle
KAPPA_RIGHT	N	Relative orientation angle
OMEGA_RIGHT	N	Relative orientation angle
MAXPARALLAX	N	Maximum value of residual vertical parallax
RMSPARALLAX	N	RMS value of residual vertical parallax
MAXXPAR	N	Maximum value of residual parallel parallax
MINXPAR	N	Minimum value of residual parallel parallax

Strips table "routes.db"

ROUTE	I	Unique index of strip
ROUTE_ORD	I	Ordinal number of strip
ROUTE_NAME	C16	Strip name
DIRECT	I	Direction of images in strip

Scanner survey information table "values.db"
– user editing is not recommended.

6.2 *Tables editing*

You can use **PHOTOMOD Explorer** program to view and edit the database tables (see **PHOTOMOD Overview** User Manual).

Note that you should understand the database structure and links between tables very well to edit them manually.

Start **PHOTOMOD Explorer**, select a project and **AT data** section within database tables to edit it. Double click on the database table (.db resource) to open it for editing. Now you can select some field value by single mouse click and enter a new value.

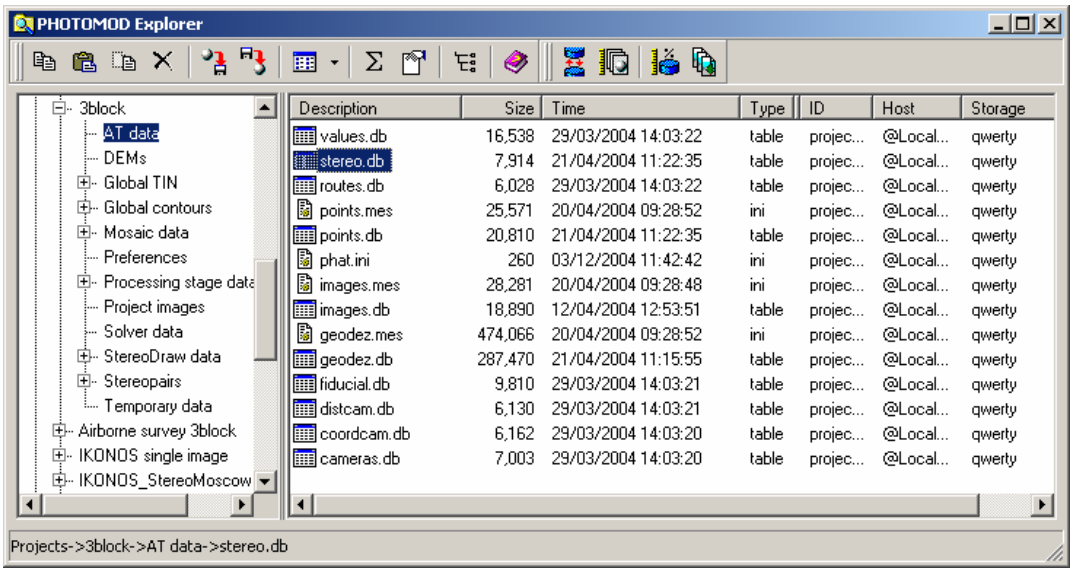
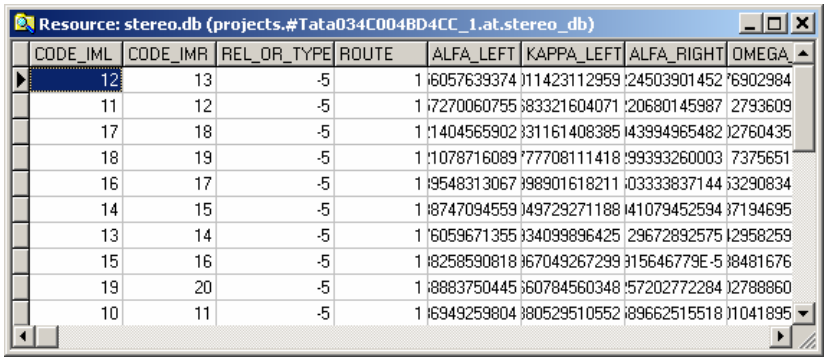

PHOTOMOD Explorer
3block
AT data
DEMs
Global TIN
Global contours
Mosaic data
Preferences
Processing stage data
Project images
Solver data
StereoDraw data
Stereopairs
Temporary data
Airborne survey 3block
IKONOS single image
IKONOS_StereoMoscow
Description Size Time Type ID Host Storage
values.db 16,538 29/03/2004 14:03:22 table projec... @Local... qwerty
stereo.db 7,914 21/04/2004 11:22:35 table projec... @Local... qwerty
routes.db 6,028 29/03/2004 14:03:22 table projec... @Local... qwerty
points.mes 25,571 20/04/2004 09:28:52 ini projec... @Local... qwerty
points.db 20,810 21/04/2004 11:22:35 table projec... @Local... qwerty
phat.ini 260 03/12/2004 11:42:42 ini projec... @Local... qwerty
images.mes 28,281 20/04/2004 09:28:48 ini projec... @Local... qwerty
images.db 18,890 12/04/2004 12:53:51 table projec... @Local... qwerty
geodez.mes 474,066 20/04/2004 09:28:52 ini projec... @Local... qwerty
geodez.db 287,470 21/04/2004 11:15:55 table projec... @Local... qwerty
fiducial.db 9,810 29/03/2004 14:03:21 table projec... @Local... qwerty
distcam.db 6,130 29/03/2004 14:03:21 table projec... @Local... qwerty
coordcam.db 6,162 29/03/2004 14:03:20 table projec... @Local... qwerty
cameras.db 7,003 29/03/2004 14:03:20 table projec... @Local... qwerty
Projects->3block->AT data->stereo.db

Fig.55 **AT data** list in **PHOTOMOD Explorer**

Double click the database table (.db resource) to open it for editing. Then select some field value by single click and enter a new value.



CODE_IML	CODE_IMR	REL_OR_TYPE	ROUTE	ALFA_LEFT	KAPPA_LEFT	ALFA_RIGHT	OMEGA_
12	13	-5	1	6057639374	011423112959	24503901452	76902984
11	12	-5	1	7270060755	83321604071	20680145987	2793609
17	18	-5	1	1404565902	31161408385	43994965482	02760435
18	19	-5	1	1078716089	77708111418	99393260003	7375651
16	17	-5	1	9548313067	98901618211	03333837144	3290834
14	15	-5	1	8747094559	49729271188	41079452594	7194695
13	14	-5	1	6059671355	34099896425	29672892575	2958259
15	16	-5	1	8258590818	67049267299	315646779E-5	8481676
19	20	-5	1	8883750445	60784560348	57202772284	2788860
10	11	-5	1	6949259804	80529510552	89662515518	1041895

Fig.56 Database table editing